UNIVERSITY OF PATRAS

Department Of Chemical Engineering

ChemEngUP

2015-2016

Departmental Curicculum

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ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΑΤΡΩΝ
UNIVERSITY OF PATRAS

SCHOOL of ENGINEERING
DEPARTMENT of CHEMICAL ENGINEERING

DEPARTMENTAL CURRICULUM
of
Undergraduate Studies

2015 - 2016

ChemEngUP

Edited by S. Bebelis, Associate Professor

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1. THE DEPARTMENT OF CHEMICAL ENGINEERING – OVERVIEW

The Department of Chemical Engineering (DCE), of the University of Patras was established in 1977 and is a part of the School of Engineering. The mission of DCE is to produce chemical engineers educated in research, development and optimization of processes for the production of industrial products as well as in materials technology, environmental protection and energy production.

DCE meets the modern trends and international dynamics of the science of chemical engineering, which pioneers in areas such as biotechnology and biological engineering, nanotechnology and soft and alternative energy forms, being a center of excellence in several areas.

Education and research in DCE are carried out according to international quality standards and have resulted in numerous distinctions of the Department, faculty and alumni who have proven able to meet with success in the highly competitive Greek, European and international environment.

Faculty and staff members in DCE are involved in important research projects, in collaboration with some of the top universities and research centers globally, funded by European research programs, the Greek State as well as by industrial partners.

The Department of Chemical Engineering is housed in two modern buildings located at the University of Patras Campus, with magnificent views of the mountains of Peloponnese and the Gulf of Patras.

Additional information about the people, the studies and research in DCE can be found in the Department website (www.chemeng.upatras.gr).

2. UNDERGRADUATE STUDIES – GENERAL INFORMATION

Undergraduate studies at the Department of Chemical Engineering last five (5) academic years, divided in ten (10) semesters. The academic year starts on September 1st and ends on August 31st. Normally, classes of the fall semester begin on October 1st and classes of the spring semester on February 16th. The exact dates are announced in the DCE website (www.chemeng.upatras.gr).

During each semester a student has to attend a number of compulsory and elective courses, including laboratory practice. Attendance in laboratory courses is mandatory. The total number of European Credit Transfer and Accumulation System (ECTS) units per semester is equal to 30. In order to graduate, obtaining a Diploma in Chemical Engineering, a student has to pass the exams associated with all compulsory (43) and a minimum number of elective courses (11 out of 53), corresponding in total to a minimum number of Teaching Units T.U., as specified by the Department. In this number are included the T.U. corresponding to the Diploma Thesis (48 T.U.), which is compulsory. A student has to work for a minimum of two semesters in order to complete the Diploma Thesis, which is supervised by a faculty member and assessed and graded by a Committee of three faculty members. Assignment of a particular number of T.U. to each course is determined by the Greek Legislation. Specifically, one (1) T.U. corresponds to one (1) hour lecture per week per semester whereas for recitation classes and laboratory work one (1) T.U. corresponds to two (2) hours per week per semester.

A course is considered successfully passed only when the student has obtained at least a grade 5 out of 10. This grade is based on the grade obtained in the final written exam at the end of each semester, as well as on the grade obtained in intermediate exam or exams and in homework sets or projects, which may be given by the instructor of the course. A student who fails to pass a course by the end of the corresponding semester can repeat the exam in a second examination period, in September of the same year. For laboratory courses, successful completion of a minimum number of laboratory exercises is a prerequisite for passing the course, whereas the final grade is based both in the performance of the student in the lab and in tests preceding each laboratory exercise.

Courses are offered in Greek. Nevertheless, in addition to personal advising, textbooks written in English are normally recommended by the course instructors to ERASMUS students who have not a good command of the Greek language, so that they are able to attend the courses and pass the exams which can be given in English. A Course of Greek Language for foreign students is available. Prospective ERASMUS students can contact Professor Petros Koutsoukos (pgk@chemeng.upatras.gr) for further details.

3. PROGRAM OF STUDIES – ACADEMIC YEAR 2015-2016

1st Year – 1st Semester

C.N	COURSES	HOURS/WEEK T	R	L	TU	ECTS credits	INSTRUCTOR
	COMPULSORY COURSES						
CHM_102	Single Variable Calculus and Linear Algebra	4	2	_	5	6	P. Vafeas
CHM_115	Analytical Chemistry	2	1	_	3	4	G. Staikos
CHM_140	Introduction to Chemical Engineering	3	2*	_	4	4	C. Vayenas - A. Katsaounis
CHM_130	Physics I	3	1	_	4	5	D. Kouzoudis
CHM_110	General and Inorganic Chemistry	3	1	_	4	5	P. Koutsoukos
CHM_163	Computers Laboratory	_	_	3	2	3	D. Mataras
	* 1 hour Seminar						
	ELECTIVES: GROUP A						
CHM_189	Cognitive Analysis of Learning in Education	3	_	_	3	3	It will not be taught
CHM_191	English I	3	_	_	3	3	Foreign Languages Teaching Unit
CHM_192	French I	3	_	_	3	3	Foreign Languages Teaching Unit
CHM_193	German I	3	_	_	3	3	Foreign Languages Teaching Unit
CHM_194	Italian I	3	_	_	3	3	Foreign Languages Teaching Unit
CHM_195	Russian I	3	_	_	3	3	Foreign Languages Teaching Unit
	SUM		**28**		**25**	**30**	

NOTES:

Two (2) courses must be elected from the ELECTIVES: GROUP A of the 1st and 2nd semester (one course per semester)

1st Year – 2nd Semester

C.N	COURSES	HOURS/WEEK T	R	L	TU	ECTS credits	INSTRUCTOR
	COMPULSORY COURSES						
CHM_201	Multivariable Calculus and Vector Analysis	4	2	_	5	7	P. Vafeas
CHM_212	Organic Chemistry	3	2	_	4	7	E. Amanatides
CHM_215	Laboratory of Analytical Chemistry	_	_	4	2	3	G. Staikos
CHM_230	Physics II	3	1	_	4	7	D. Kouzoudis
CHM_232	Physics Laboratory	_	_	4	2	3	S. Kennou - D. Kouzoudis
	ELECTIVES: GROUP A						
CHM_285	Introduction to Science Education	3	_	_	3	3	Dept. of Educational Sciences and Early Childhood Education
CHM_286	Philosophy of Sciences	3	_	_	3	3	It will not be taught
CHM_291	English II	3	_	_	3	3	Foreign Languages Teaching Unit
CHM_292	French II	3	_	_	3	3	Foreign Languages Teaching Unit
CHM_293	German II	3	_	_	3	3	Foreign Languages Teaching Unit
CHM_294	Italian II	3	_	_	3	3	Foreign Languages Teaching Unit
CHM_295	Russian II	3	_	_	3	3	Foreign Languages Teaching Unit
	SUM		**26**		**20**	**30**	

2nd Year – 3rd Semester

C.N	COURSES	HOURS/WEEK T	R	L	TU	ECTS credits	INSTRUCTOR
	COMPULSORY COURSES						
CHM_300	Ordinary Differential Equations	3	2	_	4	6	S. Pandis
CHM_311	Organic Chemistry Laboratory	_	_	4	2	3	C. Tsitsilianis
CHM_220	Thermodynamics I	3	2	_	4	7	S. Boghosian
CHM_363	Computer Programming for Chemical Engineers	4	_	3	5	7	D. Mataras
CHM_421	Physical Chemistry	4	2	_	5	7	D. Kontarides - A.Katsaounis
	SUM		**27**		**20**	**30**	

2nd Year – 4th Semester

C.N	COURSES	HOURS/WEEK T	R	L	TU	ECTS credits	INSTRUCTOR
	COMPULSORY COURSES						
CHM_402	Partial Differential Equations	2	1	_	3	4	S. Pandis
CHM_521	Physical Chemistry Laboratory	_	_	4	2	3	S. Boghosian - A. Katsaounis
CHM_660	Numerical Analysis	3	1	3	5	8	Y.Dimakopoulos
CHM_320	Thermodynamics II	4	1	_	5	7	S. Boghosian
CHM_582	Mechanics of Materials	3	1	_	4	5	C. Galiotis
CHM_202	Statistics for Engineers	2	1	_	3	3	S. Pandis
	SUM		**26**		**22**	**30**	

3rd Year – 5th Semester

C.N	COURSES	HOURS/WEEK T	R	L	TU	ECTS credits	INSTRUCTOR
	COMPULSORY COURSES						
CHM_550	Fluid Mechanics	3	2	_	4	6	Y.Dimakopoulos
CHM_570	Polymer Science	3	1	_	4	5	C. Tsitsilianis
CHM_540	Technical Thermodynamics and Balances	3	2	_	4	6	S. Ladas - D. Spartinos
CHM_381	Materials Science	3	2	_	4	6	G.Angelopoulos- S. Kennou
CHM_680	Microbiology	3	_	_	3	4	D. Vayenas
CHM_481	Materials Laboratory	_	_	4	2	3	V. Stivanakis
	SUM		**26**		**21**	**30**	

3rd Year – 6th Semester

C.N	COURSES	HOURS/WEEK T	R	L	TU	ECTS credits	INSTRUCTOR
	COMPULSORY COURSES						
CHM_650	Heat Transfer	3	2	_	4	6	P. Vafeas
CHM_755	Mass Transfer	2	1	_	3	4	D. Mantzavinos
CHM_515	Instrumental Chemical Analysis	2	2	_	3	4	A. Katsaounis- S.Bebelis
CHM_741	Chemical Reaction Engineering I	3	1	_	4	6	C. Vayenas
CHM_840	Process Dynamics and Control	3	2	1	5	7	I. Kookos- S. Pavlou
CHM_671	Polymers Laboratory	_	_	4	2	3	C. Tsitsilianis
	SUM		**26**		**21**	**30**	

4th Year - 7th Semester

C.N	COURSES	HOURS/WEEK T	R	L	TU	ECTS credits	INSTRUCTOR
	COMPULSORY COURSES						
CHM_655	Unit Operations I	2	2	2	4	6	Ch. Paraskeva
CHM_742	Biochemical Process Engineering	3	2	_	4	6	D. Mantzavinos
CHM_941	Plant Design and Economics	4	1	-	5	6	I. Kookos
CHM_756	Chemical Engineering Processes Laboratory I	_	_	4	2	3	Ch. Paraskeva - D. Spartinos
CHM_841	Chemical Reaction Engineering II	3	2	_	4	6	X. Verykios
	ELECTIVES: GROUP B						
CHM_794	Economics of Innovation and Technology	2	1	_	3	3	Dept. of Economics
CHM_792	Basic Principles of Law	2	1	_	3	3	Dept. of Economics
CHM_893	Environment and Natural Resource Economics for non-Economists	3	_	_	3	3	Dept. of Economics
	SUM	**29**			**22**	**30**	

NOTES:

Three (3) courses must be elected from the ELECTIVES:GROUP B, specifically one course from the electives of the 7th semester and two courses from the electives of the 8th semester

4th Year – 8th Semester

C.N	COURSES	HOURS/WEEK T	R	L	TU	ECTS credits	INSTRUCTOR
	COMPULSORY COURSES						
CHM_1041	Plant Design and Economics Laboratory	4	_	4	6	10	I. Kookos - D. Vayenas
CHM_846	Chemical Engineering Process Laboratory II	_	_	4	2	3	Ch.Paraskeva - M. Kornaros
CHM_855	Unit Operations II	2	2	2	4	6	D. Mataras
CHM_835	Industrial Chemical Technologies	3	1	_	4	5	D. Spartinos
	ELECTIVES: GROUP B						
CHM_891	Business Administration	2	1	_	3	3	Dept. of Mechanical Eng. & Aeronautics
CHM_898	Practical Training in Industry & Enterprises	3	_	_	3	3	G. Angelopoulos
CHM_899	Economics for non-Economists	3	_	_	3	3	It will not be taught
CHM_881	Management Information Systems I	3	_	_	3	3	Dept. of Mechanical Eng. & Aeronautics
CHM_882	Operations Strategy	3	_	_	3	3	Dept. of Mechanical Eng. & Aeronautics
CHM_883	Technology - Innovation - Entrepreneurship	3	_	_	3	3	Dept. of Mechanical Eng. & Aeronautics
	SUM	**28**			**22**	**30**	

5th Year – 9th Semester

C.N	COURSES	HOURS/WEEK T	R	L	TU	ECTS credits	INSTRUCTOR
	COMPULSORY COURSES						
CHM_Δ00	Diploma Thesis	_	_	_	0	0	
CHM_Δ01	Diploma Thesis I	_	_	_	4	3	
CHM_Δ02	Diploma Thesis II	_	_	_	4	3	
CHM_Δ03	Diploma Thesis III	_	_	_	4	3	
CHM_Δ04	Diploma Thesis IV	_	_	_	4	3	
CHM_Δ05	Diploma Thesis V	_	_	_	4	3	
CHM_Δ06	Diploma Thesis VI	_	_	_	4	3	
	CATEGORY ELECTIVES: ADVANCED & SPECIALIZATION COURSES						
CHM_E12	Applications of Partial Differential Equations (A)	3	_	_	3	4	P. Vafeas
CHM_E36	Heterogeneous Catalysis (A)	3	_	_	3	4	S. Bebelis
CHM_E56	Special Topics in Fluid Mechanics (A)	3	_	_	3	4	It will not be taught
CHM_E67	Process Optimization (A)	3	_	_	3	4	I. Kookos
CHM_E63	Molecular Spectroscopy (A)	3	_	_	3	4	D. Kontarides
CHM_E66	Process Control (A)	3	_	_	3	4	It will not be taught
CHM_E68	Systems Dynamics (A)	3	_	_	3	4	S. Pavlou
CHM_E50	Rheology of Polymers (B)	3	_	_	3	4	Y. Dimakopoulos
CHM_E57	Biomechanics I (B)	3	_	_	3	4	Dept. of Mechanical Eng. & Aeronautics
CHM_E60	Practical Software Applications (B)	3	_	_	3	4	It will not be taught
CHM_E70	Nanostructured Polymers (B)	3	_	_	3	4	G. Staikos
CHM_E33	Microelectronics Technology (B)	3	_	_	3	4	D. Mataras
CHM_E82	Materials Protection Technology (B)	3	_	_	3	4	V. Stivanakis
CHM_E83	Composite and Nanocomposite Materials (B)	3	_	_	3	4	C. Galiotis
CHM_E85	Ceramics & Inorganic Binding Materials (B)	3	_	_	3	4	V. Stivanakis
CHM_E54	Bioreactor Analysis and Design (B)	3	_	_	3	4	S. Pavlou
CHM_E92	Environmental Technology: Urban Wastewater Treatment (B)	3	_	_	3	4	M. Kornaros
CHM_E93	Biotechnology (B)	3	_	_	3	4	It will not be taught
CHM_E94	Biomaterials (B)	3	_	_	3	4	E. Amanatides
	SUM		**9**		**33**	**30**	

C.N	COURSES	HOURS/WEEK T	R	L	TU	ECTS credits	INSTRUCTOR

NOTES:

From the CATEGORY ELECTIVES, offered in the 9th and 10th semester, six (6) must be elected: **At least two (2)** courses from Category A (Advanced courses) and **maximum four (4)** courses from Category B (Specialization courses). Three courses per semester must be elected.

5th Year – 10th Semester

C.N	COURSES	HOURS/WEEK T	R	L	TU	ECTS credits	INSTRUCTOR
	COMPULSORY COURSES						
CHM_Δ07	Diploma Thesis VII	_	_	_	4	3	
CHM_Δ08	Diploma Thesis VIII	_	_	_	4	3	
CHM_Δ09	Diploma Thesis IX	_	_	_	4	3	
CHM_Δ10	Diploma Thesis X	_	_	_	4	3	
CHM_Δ11	Diploma Thesis XI	_	_	_	4	3	
CHM_Δ12	Diploma Thesis XII	_	_	_	4	3	
	CATEGORY ELECTIVES: ADVANCED & SPECIALIZATION COURSES						
CHM_E31	Electrochemical Processes (A)	3	_	_	3	4	S. Bebelis
CHM_E40	Reactor Analysis and Design (A)	3	_	_	3	4	X. Verykios
CHM_E69	Transport Phenomena Simulation (A)	2	_	4	3	4	Y. Dimakopoulos
CHM_E23	Special Topics in Physical Chemistry (A)	3	_	_	3	4	V. Mavratzas
CHM_E20	Physicochemical Processes of Materials (B)	3	_	_	3	4	S. Kennou
CHM_E30	Surface Science (B)	3	_	_	3	4	S. Ladas
CHM_E52	Environmental Technology: Solid Waste Treatment (B)	3	_	_	3	4	M. Kornaros
CHM_E91	Environmental Technology: Industrial Wastewater Treatment (B)	3	_	_	3	4	D. Mantzavinos
CHM_E55	Soft (Renewable) Energy Sources (B)	3	_	_	3	4	E. Amanatides
CHM_E58	Biomechanics II (B)	3	_	_	3	4	Dept. of Mechanical Eng. & Aeronautics
CHM_E61	Suspensions & Emulsions (B)	3	_	_	3	4	P. Koutsoukos
CHM_E80	Metallurgy (B)	3	_	_	3	4	G. Angelopoulos
	SUM				**33**	**30**	

CATEGORY ELECTIVES: ADVANCED AND SPECIALIZATION COURSES

C.N.	COURSES	HOURS/WEEK T	R	L	TU	ECTS credits
	A. ADVANCED COURSES IN CHEMICAL ENGINEERING					
CHM_E12	Applications of Partial Differential Equations (A)	3	_	_	3	4
CHM_E31	Electrochemical Processes	3	_	_	3	4
CHM_E36	Heterogeneous Catalysis	3	_	_	3	4
CHM_E40	Reactor Analysis & Design	3	_	_	3	4
CHM_E56	Special Topics in Fluid Mechanics	3	_	_	3	4
CHM_E63	Molecular Spectroscopy	3	_	_	3	4
CHM_E66	Process Control	3	_	_	3	4
CHM_E67	Process Optimization	3	_	_	3	4
CHM_E68	Systems Dynamics	3	_	_	3	4
CHM_E69	Transport Phenomena Simulation	2	_	4	4	4
CHM_E23	Special Topics in Physical Chemistry (A)	3	_	_	3	4
	B. SPECIALIZATION COURSES IN CHEMICAL ENGINEERING					
	ENVIRONMENT/ENERGY					
CHM_E52	Environmental Technology: Solid Waste Treatment	3	_	_	3	4
CHM_E55	Soft (Renewable) Energy Sources	3	_	_	3	4
CHM_E60	Practical Software Applications	3	_	_	3	4
CHM_E91	Environmental Technology: Industrial Wastewater Treatment	3	_	_	3	4
CHM_E92	Environmental Technology: Urban Wastewater Treatment	3	_	_	3	4
	MATERIALS					
CHM_E20	Physicochemical Processes of Materials	3	_	_	3	4
CHM_E30	Surface Science	3	_	_	3	4
CHM_E33	Microelectronics Technology	3	_	_	3	4
CHM_E50	Rheology of Polymers	3	_	_	3	4
CHM_E61	Suspensions & Emulsions	3	_	_	3	4
CHM_E70	Nanostructured Polymers	3	_	_	3	4
CHM_E80	Metallurgy	3	_	_	3	4
CHM_E82	Material Protection Technology	3	_	_	3	4
CHM_E85	Ceramics & Inorganic Binding Materials	3	_	_	3	4
CHM_E83	Composite and Nanocomposite Materials	3	_	_	3	4
	BIOTECHNOLOGY					
CHM_E54	Bioreactor Analysis and Design	3	_	_	3	4

C.N.	COURSES	HOURS/WEEK				
		T	R	L	TU	ECTS credits
CHM_E57	Biomechanics I	3	_	_	3	4
CHM_E58	Biomechanics II	3	_	_	3	4
CHM_E93	Biotechnology	3	_	_	3	4
CHM_E94	Biomaterials	3	_	_	3	4

4. DESCRIPTION OF UNDERGRADUATE COURSES

1st Year – 1st Semester

Single Variable Calculus and Linear Algebra

Course title	**Single Variable Calculus and Linear Algebra**
Course code	**CHM_102**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	1st
Semester	1st
ECTS credits	6
Name of lecturer	Panayiotis Vafeas
Learning outcomes	At the end of this course the student should be able to: 1. Have a good understanding of the knowledge of the basic applied mathematics for engineers, within the wide area of the differential and integral calculus of one variable, of the series of numbers and functions, as well as of the linear algebra, which is adequate to his/her science. 2. Know the new notions in the form of definitions and theorems that concern the basic contents of the course "Single Variable Calculus and Linear Algebra", in order to be able to apply them. 3. Combine and make worthy of the knowledge that he/she acquired to other fields of the theoretical and applied mathematics, in which certain notions and principles of the present course are necessary and useful.
Competences	At the end of the course the student will have further developed the following skills and competences: 1. Ability to demonstrate knowledge and understanding of essential concepts, principles and applications that are related to the differential and integral calculus of one variable, to the series of numbers and functions, as well as to the linear algebra. 2. Ability to apply such knowledge to the solution of problems in other fields of the wide conception of theoretical and applied mathematics, related to the science of Chemical Engineering, or to the solution of multidisciplinary problems. 3. Study skills needed for continuing profession development.
Prerequisites	There are no prerequisite courses. It is, however, recommended that students should have a basic knowledge of the differential and integral calculus of one variable, as well as of the principal theory of vectors from school.

Course contents	Cartesian and polar coordinates on the plane, introduction to the calculus of one variable and the method of the mathematical induction. Functions of one variable, the conception of representation, limit and continuity, Boltzano's theorem. Derivative of first or higher order of functions and geometrical meaning, derivation rules and total differential. Inverse and composite functions, parametric equations, complex forms and L' Hospital's rule. Analysis, monotony and extremities of functions, asymptotes. Fermat's theorem and theorems of mean value. Sequences, number series and convergence criterions. Series of functions, uniform convergence criterions and power series. Generalized mean value theorem or Taylor's formula and local approximation of function, binomial expansion. Taylor's and Maclaurin's series, binomial series and convergence. Fourier's series and total approximation of function. Applications of derivatives with the use of method of extremities for functions of physical interest, finding the curvature of a plane curve and introduction of ordinary differential equations, solution of homogeneous and non homogeneous equations with constant coefficients, Euler's method for determination of coefficients. Indefinite integral of functions and several analytic techniques of integration. Riemann's integral, definite integral and main numerical methods of integration. Generalized integrals and their relation with the series. Applications of integrals to the calculation of plane areas, curve's length, surface areas and domain volumes by rotation. Introduction of plane vectors and the meaning of the third spatial dimension. Inner, exterior, mixed and double–exterior product, geometrical meaning. Matrix theory and square matrices, determinant and inverse matrix. Vector spaces of functions, vectors and matrices, linear dependence and independence, vector subspaces, basis and dimension, extension and change of basis in a particular vector space. Homogeneous and non homogeneous systems of linear equations, solution with Gauss' deletion method. Spectral analysis of matrix, in spaces of finite dimensions, eigenvalues and eigenvectors or characteristic magnitudes and physical meaning, Cayley–Hamilton's theorem. Algebraic and geometric multiplicity of eigenvalues, diagonalization of square matrix. Degenerate eigenvalues, degeneration degree and generalized eigenvectors, Jordan's matrix. Generalization of inner product, the meaning of norm, distance and orthonormalization with Gram–Schmidt's method.
Recommended reading	1. V.V. Markellos, "Applied Mathematics", Gotsis Publications, Patras, 2013 (Eudoxos / code **32998565**). 2. K.E. Papadakis, "Applied Mathematics", Tziolas Publications, Thessaloniki, 2014 (Eudoxos / code **41954961**).

Teaching and learning methods	1. Teaching (4 hours/week): lectures using blackboard of the theory and its application to typical mathematical problems of Chemical Engineering. 2. Recitation (2 hours/week): solving on the blackboard exercises concerning mainly mathematical applications of the science of Chemical Engineering.
Assessment and grading methods	Written examination (100% of the final mark).
Language of instruction	Greek
Course URL	None

Analytical Chemistry

Course title	**Analytical Chemistry**
Course code	**CHM_115**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	1st
Semester	1st
ECTS credits	4
Name of lecturer	Georgios Staikos
Learning outcomes	- Comprehension of the principles of chemical equilibrium, with application in solutions of electrolytes. - Extended and in depth study of the ionic equilibriums. - Calculation of concentrations from equilibrium constants.
Competences	- Comprehension of basic concepts of Analytical Chemistry, which find application in qualitative, as well in quantitative analysis, that are the object of the 2nd semester's course, Laboratory of Analytical Chemistry.
Prerequisites	- There are not prerequisite courses. - Students should have a basic knowledge of chemistry.
Course contents	- Introductory concepts. Solutions. Water as a solvent. - Chemical reactions and chemical equilibrium. - Concentration of solutions. - Reaction velocity and chemical equilibrium. - Equilibria of weak acids and weak bases. - Ionization of water, pH, protolytic indicators, buffer solutions, hydrolysis. - Equilibria of insoluble substances and their ions, solubility product, formation of precipitates. - Equilibrium of complex ions.

	- Amphoteric substances. - Equilibria of redox systems, galvanic cells.
Recommended reading	D.A. Skoog, D.M. West, F. J. Holler and S.R. Crouch, “Fundamentals of Analytical Chemistry”, 8th Edition, Brooks/Cole, Thomson, 2004.
Teaching and learning methods	- Lectures by using transparencies - Solution of problems - Homework
Assessment and grading methods	- Three or four intermediate examinations, and homework, with a possible participation at 50% in the final grade, in conjunction with the January final written exam. - Final written examination for the other two exams periods (June, September)
Language of instruction	Greek
Course URL	https://eclass.upatras.gr/courses/CMNG2139

Introduction to Chemical Engineering

Course title	**Introduction to Chemical Engineering**
Course code	**CHM_140**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	1st
Semester	1st
ECTS credits	4
Names of lecturers	Constantinos Vayenas Alexandros Katsaounis
Learning outcomes	At the end of this course the student should be able to: 1. Understand a flowsheet of a simple Chemical Industry 2. Develop the physical and mathematical model of a process. 3. Use fundamental equations and write mass and energy balances in simple processes. 4. Use differential and integral methods for the treatment of reaction rate data. 5. Write mass and energy balances of chemical compounds in simple physical processes and simple chemical reactors. 6. Use dimensional analysis in order to extract equations 7. Understand the concept of linearization.

	8. Understand the concept of Residence Time Distribution (RTD) in simple single- and multi-chemical reactors
Competences	At the end of the course the student will have further developed the following skills/competences: 1. Ability to understand a flowsheet of a simple Chemical Industry. 2. Ability to develop the physical and mathematical model of a process. 3. Ability to use fundamental equations and write mass and energy balances in simple processes. 4. Ability to use differential and integral methods for the treatment of reaction rate data. 5. Ability to write mass and energy balances of chemical compounds in simple physical processes and simple chemical reactors. 6. Ability to use dimensional analysis in order to extract equations. 7. Ability to understand the concept of linearization. 8. Ability to understand the concept of Residence Time Distribution (RTD) in simple single- and multi-chemical reactors.
Prerequisites	There are no prerequisite courses. It is, however, recommended that students should have a basic knowledge of Mathematics, Physics and Chemistry.
Course contents	Definition of Chemical Engineering science and activities of Chemical Engineers in Greece. Overview of the flowsheet of a simple Chemical Industry in relation to the courses in the Chemical Engineering curriculum. Physical and mathematical model of a process. Types of chemical and electrochemical reactors. Mass balances in simple chemical reactors and simple unit operations. Use of differential and integral methods for the treatment of reaction rate data. Dynamic behavior of simple reactors. Dimensional analysis. The concept of scale-up. The concept of linearization. Residence time distribution (RTD) in simple single- and multi-chemical reactors.
Recommended reading	1. ′′Introduction to Chemical Engineering′′ Notes of Professor Costas Vayenas 2. ′′Perry's standard tables and formulas for chemical engineers′′, Speight James G., Tziola's Editions (ISBN: 978-960-418-146-9) 3. ′′Basic principles and calculations in chemical engineering′′, Himmelblau D., Riggs J., Tziola's Editions (ISBN: 960-418-105-X)
Teaching and learning methods	Lectures using power-point presentations and problem solving based on the syllabus of the course

Assessment and grading methods	1. Problem solving by the students during the semester (1 unit bonus to the final mark if it is > 5) 2. Written examination in the middle of the semester (50% of the final mark) 3. Final written exams (50 % of the final mark) * those who participated in procedure 2 with a mark > 5 consider the final examination in the second half of the course syllabus. Those who didn't participate in procedure 2 or got a mark < 5 consider the final examination with the whole course syllabus.
Language of instruction	Greek
Course URL	https://eclass.upatras.gr//courses/CMNG2141/

Physics I

Course title	**Physics I**
Course code	**CHM_130**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	1st
Semester	1st
ECTS credits	5
Name of the lecturer	Dimitrios Kouzoudis
Learning outcome	By the end of this course the student will have acquired basic knowledge on fundamental concepts of: 1. Newtonian Mechanics: Motion in a straight line and the plane, Newton's laws, circular motion, work and kinetic energy, conservation of energy, momentum and impulse, rotational motion, composite motion, angular momentum, static equilibrium, oscillations 2. Wave Mechanics: Definition of waves. Speed. Mathematical concepts. Harmonic waves: amplitude, wavelength, frequency, period. Longitudinal-transverse waves. Applications: Waves in a string, sound waves. Reflection of waves. Superposition of waves: Stationary waves, Interference. Doppler effect.
Competences	By the end of this course the student will have developed the following skills: 1. Ability to learn and understand fundamental concepts of Newtonian mechanics and thermodynamics. 2. Ability to use this knowledge and solve complicated physical

	problems. 3. Ability to deal with unknown problems and solve them. 4. Ability to collaborate with others for the solution of scientifically oriented problems.
Prerequisites	There are no prerequisites.
Course contents	1. Introduction: Physics and Measurement 2. Motion in one dimension 3. Motion in two dimensions 4. Newton 's Laws of motion - Applications 5. Circular motion 6. Work and energy 7. Potential energy and conservation of energy 8. Linear momentum and collisions 9. Rigid body rotation 10. Mechanical Equilibrium 11. Rolling, 12. Angular Momentum 13. Oscillations 14. Mechanical waves
Suggested reading	• Physics for scientists and engineers", R.A. Serway, part I • Physics", D. Halliday and R. Resnick", Volume I • University Physics, Young Hugh D., Volume A
Teaching and learning methods	Presentation and tutorials aiming at the solution of complicated physical problems with the participation of the students.
Assessment and grading methods	Written final exam at the end of each semester. Minimum passing grade 5.
Language of instruction	Greek
Course URL	

General and Inorganic Chemistry

Course title	**General and Inorganic Chemistry**
Course code	**CHM_110**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	1st
Semester	1st
ECTS credits	5
Name of the lecturer	Petros Koutsoukos
Learning outcome	1. Develop an understanding of the structure of atoms and the development of modern atomic theory.

	2. Use the concepts of bonding and the electronic structure of the atom to predictthe three-dimensional shapes and electron distributions withinmolecules. 3. Use information embedded in the periodic table to predict the chemical properties and electronic structure of elements. 4. Correctly use symbolism and vocabulary to communicate chemical ideas.
Competences/Skills	• Understanding principles underlying chemical changes at the molecular and atomic level • Relate knowledge of chemical phenomena with every-day life.
Prerequisites	There are no formal prerequisites.
Course contents	Atoms, molecules and ions. Atomic theory: From Democritus to Dalton and to modern concepts for the structure of the atoms. Quantum mechanics, quantum numbers and quantum theory of atomic structure. Bohr's theory for Hydrogen atom. De Broglie's theory. The periodic table of the elements. Periods and groups. Metals, non-metals and metalloids. Oxidation and reduction and the oxidation numbers. The periodic properties of the atoms and their electronic configuration. The Aufbau principle and the exceptions. Shielding, penetration and effective nuclear charge. Writing electronic configurations of atoms based on the periodic table. The chemical bond. Lewis notation. Formal charge and resonance. Chemical bond parameters. Molecular geometry (VSEPR theory). The theory of chemical bonding. Valence bond theory, hybridization and molecular orbital theory. States of matter: solids and liquids. Intermolecular forces. Chemical equilibrium. Acids and Bases. Complexes formation of the transition metals and their properties. Crystal field theory and valence bond theory for the transition metal complexes.
Suggested reading	• Ebbing: General Chemistry, 4th Ed., Houghton, 1993. Transl. in Greek , Travlos Publ., 2002 • Applied Inorganic Chemistry (in Greek), S. Liodakis, Parisianos Publ., 2003 • Fundamentals of Inorganic Chemistry (in Greek), G.Pnevmatikakis, Ch.Mitsopoulou, K.Methenitis, Stamoulis Publ., 2006 • General Chemistry, P.W.Atkins, Scientific American, 1992
Teaching and learning methods	Lectures using electronic and conventional means. Analytic presentation of selected examples. Student guidance to seek internet and other course related Literature information. Selected demonstration experiments
Assessment and grading methods	Series of homework problems at the tutoring sessions (10% of the final grade). Optional Midterm exams every week (15% of the final grade). The rest 75% is from the final exam at the end of the course.

Language of instruction	Greek
Course URL	https://eclass.upatras.gr/courses/CMNG2122/

Computers Laboratory

Course title	**Computers Laboratory**
Course code	**CHM_163**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	1^{st}
Semester	1^{st}
ECTS credits	3
Name of the lecturer	Dimitrios S. Mataras
Learning outcome	Introduction to basic computing techniques for students with limited computer skills. Analytical and algorithmic engineering problem solving and data visualization.
Competences/Skills	A) Using EXCEL spreadsheets for basic engineering problem solving. B) Using MATLAB for basic engineering problem solving.
Prerequisites	No prerequisites
Course contents	Computational tools. Analytical and algorithmic problem solving. Data visualization. Introduction to EXCEL, using the spreadsheet, data formatting, excel functions, logic expressions, iterative solution, lookup tables, linear regression, data visualization in EXCEL. Introduction to MATLAB, command line processing, script files, single and two dimensional matrices, plotting in MATLAB. MATLAB programming, branching and loops, data output. Elementary applications: roots of equations, matrix operations, solving systems of equations, numerical integration and optimization. **Keywords:** Computer programming, EXCEL, MATLAB
Suggested reading	1. Engineering Computations, An Introduction Using MATLAB and EXCEL. J. C. Musto, W. E. Howard and R. R. Williams. McGraw Hill 2009. ISBN 978-007-126357-3 2. MATLAB για Μηχανικούς. A. Biran and M. Breiner (3^{rd} edition). Εκδόσεις Τζιόλα 2003. ISBN 960-418-012-6 3. eclass materials: Lecture presentations, Solved past exam subjects.

Teaching and learning methods	Includes 3 hr/week lectures using computer presentation in computer lab (1 computer/student). In addition students deliver homework papers via eclass. Instructor accessible for at least 2 hr/week for office consultation or anytime through eclass/email.
Assessment and grading methods	A) Weekly lab/eclass evaluation B) Written examination
Language of instruction	Greek
Course URL	https://eclass.upatras.gr/courses/CMNG2112/ only for registered users

Cognitive Analysis of Learning in Education

Course title	**Cognitive Analysis of Learning in Education**
Course code	**CHM_189**
Type of course	Elective
Level of course	Undergraduate
Year of study	1st
Semester	1st
ECTS credits	3
Name of the lecturer	It will not be taught
Learning outcome	The purpose of this introductory course is to give students the opportunity: • to acquire knowledge about all issues related to the process of learning and the acquisition of knowledge. • to acquaint themselves with important introductory concepts in this research area, as perception, memory, language, thought, etc. (see below, course content).
Competences/Skills	At the end of the course, the student is expected to develop the following skills: 1. To recognize and understand the basic mechanisms related to learning process, as to how we perceive reality, how and what we remember, how, what, and why we forget, how we comprehend, how we read, how we can improve learning, how we think, how we solve problems, etc. 2. To choose relevant cognitive strategies and techniques in order to assess and improve the learning process of themselves or others (as in teaching).
Prerequisites	There are no prerequisite courses.

Course contents	During the course, there are going to be discussed the following topics: • The concepts of learning and knowledge. • The cognitive analysis of learning and knowledge acquisition as compared to behaviourism. Critical analysis of behaviourism. • Learning as information processing. • Perception and recognition of information. • Memory: retention and recall of information. Working memory, short-term memory, long-term memory. • Comprehension and memory. Representation of information in memory. • Language as a means of communication and learning. Learning of oral and written language. Relation between oral and written language. • Thinking. Relation between language and thought. • Problem solving. • Learning disabilities. The specific learning disability of Dyslexia. • Conclusions, implications and applications of the cognitive analysis of learning to education. **Keywords:** Learning, Cognitive approaches to Learning, Cognitive processes
Suggested reading	**Porpodas, K. (2011).** *Learning and Knowledge in Education.* Patras (self-edition). **Kostaridou-Eukleidi, A. (2011).** *Metacognitive Processes and Self-regulation*. Athens: Pedio. Banyard, P. & Hayes, N. (1995). *Thought and Problem-Solving.* Athens: Greek Letters. Eysenck, M. (2010). *Basic principles of Cognitive Psychology.* Athens: Dardanos. Hayes, N. (1997). *Introduction to cognitive operations.* Athens: Greek Letters. Holloway, C., Eisenstadt, M., Wason, P. (1985). *Learning and Education.* Athens: Koutsoumbos. Koutsoukos, A. P. & Smirnaiou, Z. G. (2008). *Cognitive Psychology and Didactics.* Athens: Herodotos. Bablekou, Z. (2011). *Cognitive Psychology. Models of Memory.* Athens: Gutenberg. Payne, D., Douglas, J.H., Yoder, C., & Gruneberg, M. (2010). *Applied Cognitive Psychology.* Athens: Pedio.
Teaching and learning methods	Lectures using slides (MS PowerPoint).

	Interactive communication and discussions in the classroom based on small videos on the course topics. The students are provided with a small leaflet containing all the relevant information concerning the module, as the course content and its aims, as well as bibliographic references on the subject. They are also guided in literature search and in retrieving relevant information from the Internet. Students are provided with one basic textbook based on their choice via 'Eudoxos'.
Assessment and grading methods	Final written exam. The written exams comprise theoretical questions based on the course content.
Language of instruction	Greek
Course URL	https://eclass.upatras.gr/courses/PDE1455/

English I

Course title	**English I**
Course code	**CHM_191**
Type of course	Elective
Level of course	Undergraduate
Year of study	1st
Semester	1st
ECTS credits	3
Name(s) of lecturer(s)	Foreign Languages Teaching Unit

French I

Course title	**French I**
Course code	**CHM_192**
Type of course	Elective
Level of course	Undergraduate
Year of study	1st
Semester	1st
ECTS credits	3
Name(s) of	Foreign Languages Teaching Unit

lecturer(s)	

German I

Course title	**German I**
Course code	**CHM_193**
Type of course	Elective
Level of course	Undergraduate
Year of study	1st
Semester	1st
ECTS credits	3
Name(s) of lecturer(s)	Foreign Languages Teaching Unit

Italian I

Course title	**Italian I**
Course code	**CHM_194**
Type of course	Elective
Level of course	Undergraduate
Year of study	1st
Semester	1st
ECTS credits	3
Name(s) of lecturer(s)	Foreign Languages Teaching Unit

Russian I

Course title	**Russian I**
Course code	**CHM_195**
Type of course	Elective
Level of course	Undergraduate
Year of study	1st
Semester	1st
ECTS credits	3
Name(s) of lecturer(s)	Foreign Languages Teaching Unit

1st Year – 2nd Semester

Multivariable Calculus and Vector Analysis

Course title	**Multivariable Calculus and Vector Analysis**
Course code	**CHM_201**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	1st
Semester	2nd
ECTS credits	7
Name of the lecturer	Panayiotis Vafeas
Learning outcome	At the end of this course the student should be able to: 1. Have a good understanding of the knowledge of the basic applied mathematics for engineers, within the wide area of the differential and integral calculus of many variables, as well as of the vector analysis, which is adequate to his/her science. 2. Know the new notions in the form of definitions and theorems that concern the basic contents of the course "Multivariable Calculus and Vector Analysis", in order to be able to apply them.. 3. Combine and make worthy of the knowledge that he/she acquired to other fields of the theoretical and applied mathematics, in which certain notions and principles of the present course are necessary and useful.
Competences/Skills	At the end of the course the student will have further developed the following skills and competences: 1. Ability to demonstrate knowledge and understanding of essential concepts, principles and applications that are related to the differential and integral calculus of many variables, as well as to the vector analysis. 2. Ability to apply such knowledge to the solution of problems in other fields of the wide conception of theoretical and applied mathematics, related to the science of Chemical Engineering, or to the solution of multidisciplinary problems. 3. Study skills needed for continuing profession development.
Prerequisites	There are no prerequisite courses. It is, however, recommended that students should have the basic knowledge of the differential and integral calculus of one variable, as well as of the linear algebra, which they were taught to the corresponding course "Single Variable Calculus and Linear Algebra".
Course contents	Cartesian, cylindrical and spherical coordinates in space. Cylindrical surfaces and second degree surfaces. Functions of many variables, limit, continuity, partial derivative of first or higher order of functions and geometrical meaning. Derivation

	rules, Schwartz's theorem and directional derivative. Total differential and the conception of differentiation. Composite functions and homogeneous equations, complex forms and basic existence theorems. Jacobian determinant and functional dependence. Taylor's and Maclaurin's mean value theorems. Extremities of functions and binded extremities, Lagrange's multipliers. Vector analysis and vectors in space. Limit, continuity and derivative of vector functions of one and many variables. Elements of the differential geometry of curves in space. Position vector of particle, vector velocity and acceleration. Unit tangential and unit perpendicular vector of curve. Orthogonal coordinate system or trihedral Frenet–Serret, curvature and turning of curve. Gradient or grade of scalar functions, divergence and rotation or swirling of vector functions, their physical meaning and basic vector identities. Laplace's differential operator, harmonic functions and partial differential equations of Helmholtz, wave and diffusion. Irrotational and solenoidal fields, Helmholtz's decomposition theorem. Curvilinear coordinate systems, vector meaning of Jacobian determinant, special orthogonal and curvilinear coordinates, transformations and change of coordinates. Applications of partial derivatives to geometry, tangential plane and perpendicular straight line to surface, tangential straight line and perpendicular plane to curve. Multiple integration of functions, double and triple integrals, change of coordinate system and applications to the calculation of plane surface areas, of volumes of three–dimensional domains, of mass, of moments of inertia and of gravity center. Curve integrals of the first and of the second kind, application to the calculation of the force work and Green's theorem for the plane. The meaning of the circulation of vector functions, curve integrals independent of the root of integration and applications. Surface integrals and surface parameterization, application to the calculation of the area of arbitrary surface in space. Gauss' and Stokes' or Green's for the space integral theorems and their physical meaning.
Suggested reading	1. P.M. Hatzikonstantinou, "Mathematical Methods for Engineers and Scientists: Calculus of Functions with Many Variables and Vector Analysis", P.M. Hatzikonstantinou Publications, Patras, 2014 (Eudoxos / code **33362172**). 2. R.L. Finney, M.D. Weir and F.R. Giordano, "Infinitesimal Calculus" (translation M. Antonogiannakis), Institute of Tecnology & Research – University of Crete Publications, Herakleion, 2012 (Eudoxos / code **22689021**).
Teaching and learning methods	1. Teaching (4 hours/week): lectures using blackboard of the theory and its application to typical mathematical problems of Chemical Engineering.

	2. Recitation (2 hours/week): solving on the blackboard exercises concerning mainly mathematical applications of the science of Chemical Engineering.
Assessment and grading methods	Written examination (100% of the final mark).
Language of instruction	Greek
Course URL	None

Organic Chemistry

Course title	**Organic Chemistry**
Course code	**CHM_212**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	1^{st}
Semester	2^{nd}
ECTS credits	7
Name of the lecturer	Eleftherios Amanatides
Learning outcome	At the end of this course the student should be able to predict: A. The nomenclature and structure of organic compounds and functional groups B. The types of intermolecular forces and their effect on the physical properties of organic compounds C. The main reaction mechanisms of organic molecules as: Nucleophilic Substitution (SN1 and SN2), Nucleophilic Elimination (E1 and E2), Electrophilic Addition Reactions and Markovnikov rule, Free Radical Reactions and Electrophilic Aromatic Substitution Reactions D. The main mechanisms of synthesis of the most important organic compounds and families.
Competences/Skills	At the end of the course the student will have further developed the following skills/competences: A. The ability to predict the structure and the name of the organic compounds and functional groups. B. The ability to compare the physical properties between different molecules (melting, boiling point, acidity, solvent power) C. Predict the outcome of an acid – base reaction according to the compounds that participate. D. Predict the different conformation and the stability of different linear and cyclic alkanes.

	E. Predict the relative rate of different reactions according to their activation energy. F. Predict the reaction mechanism (Substitution, Elimination, Addition, Free Radical) and the products of the reaction according to the compounds that participate G. Ability to develop a reaction mechanism for the synthesis of main organic compounds.
Prerequisites	There are no prerequisite courses. It is, however, recommended that students should have knowledge of General Chemistry, Reaction Kinetics, Atomic-Molecular Orbitals and Hybridization, Acid – Bases and Basic Thermodynamic Properties (Free Energy Gibbs, Enthalpy, Entropy)
Course contents	A. Introduction to Organic Chemistry – Chemical Bonds and Molecular Structure B. B. Organic Compounds – Functional Organic Groups – Nomenclature – Intermolecular Forces – Resonance Structures – InfraRed Spectroscopy of Organic Molecules C. Introduction to Chemical Reactions and Mechanisms – Acid – Bases and their reactions D. Nomenclature and isomerism of alkane and cycloalkanes – Conformations of alkanes and cycloalkanes E. Stereochemistry of alkanes and cycloalkanes F. Nucleophilic Substitution Reactions – Mechanisms SN1 and SN2 G. Nucleophilic Elimination Reactions – Mechanisms E1 and E2 H. Alkenes/Alkines – Electrophilic Addition Reactions in double/triple bonds - Markovnikov rules I. Mechanisms of Free Radical Reactions and Polymerization J. Aromatic Compounds – Nomenclature – Synthesis and Properties – Mechanism of Electrophilic Substitution Reactions
Suggested reading	1. Organic Chemistry - Edition: 1st/2012 - Authors: John McMurry - ISBN: 978-960-524-054-7 2. Mechanisms of Organic Chemistry Reactions at a Glance - Edition: 1st /2004 - Authors: Moloney Mark G. - ISBN: 978-960-394-245-0 3. Organic Chemistry – 10th Edition 2011- Authors: Graham Solomons and Craig B. Fryhle - ISBN 978-0-470-40141-5
Teaching and learning methods	1. Classes in PowerPoint that are uploaded for the students in the e-class site of the course 2. The instructor solve quiz and exercises during the classes 3. The students solve 8 series of exercises during the semester. One series almost every week after completion of corresponding chapters

Assessment and grading methods	1. Three exams during the semester that covers the whole course. The students that succeed to all of three exams (grade > 5) may not participate in the final exam 2. Final written exams
Language of instruction	Greek
Course URL	https://eclass.upatras.gr/courses/CMNG2116/

Laboratory of Analytical Chemistry

Course title	**Laboratory of Analytical Chemistry**
Course code	**CHM_215**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	1st
Semester	2nd
ECTS credits	3
Name of the lecturer	Georgios Staikos
Learning outcome	- Principles and methods of the qualitative and quantitative analysis. - Ion study and inorganic substances analysis with the liquid-chemical method. - Laboratory methods of qualitative semi-microanalysis. - Study of the main cations. - Theory of titrimetric analysis. - Quantitative analysis by titrimetry.
Competences/Skills	- Familiarization with simple experimental technics. - Realization of laboratory experiments and measurements. - Calculations based on experimental data.
Prerequisites	- Analytical Chemistry (XM115)
Course contents	**Qualitative analysis** - Laboratory methods of qualitative semi-microanalysis. - Classification of the cations in analytical groups and subgroups. - Reactions of the cations Ag^{+}, Pb^{2+}, Hg_2^{2+}, Cu^{2+}, Cd^{2+}, As(III), Al^{3+}, Fe^{3+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Zn^{2+}. Separation and identification. **Laboratory exercises of qualitative analysis**. - Analysis of the first analytical group of cations. Ions Ag^{+}, Pb^{2+}, Hg_2^{2+}. (Reactions of the ions, analysis of a known and an unknown solution).

	- Separation and identification of the ions Cu^{2+}, Cd^{2+}, As(III), of the second group of cations. (Analysis of a known and an unknown solution). - Separation and identification of the ions Al^{3+}, Fe^{3+},Mn^{2+}, Co^{2+}, Ni^{2+}, Zn^{2+} of the third group of cations. (Analysis of a known and an unknown solution). **Quantitative analysis** - Introduction. Errors and statistical treatment of data. - Introduction to the titrimetric methods of analysis. - Neutralization titrations. - Complexation titrations. - Precipitation titrations. - Oxidation/reduction titrations. **Laboratory exercises of quantitative analysis** - Titrimetric determination of total acid in vinegar and wine. - Titrimetric determination of sodium carbonate. - Titrimetric determination of oxalates. - Titrimetric determination of ascorbic acid. - Titrimetric determination of chlorides. - Titrimetric determination of water hardness.
Suggested reading	- T. Moeller, “Qualitative Analysis”, McGraw-Hill, New York, 1958. - D.A. Skoog, D.M. West, F. J. Holler and S.R. Crouch, “Fundamentals of Analytical Chemistry”, 8th Edition, Brooks/Cole, Thomson, 2004.
Teaching and learning methods	- Lectures by using transparencies. - Realization of individual laboratory experiments.
Assessment and grading methods	- Grade of the laboratory experiment, as it results from the evaluation of the report delivered for each laboratory exercise, 50%. - Final exam, 50%.
Language of instruction	- Greek
Course URL	- https://eclass.upatras.gr/courses/CMNG2140

Physics II

Course title	**Physics II**
Course code	**CHM_230**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	1st
Semester	2nd
ECTS credits	7

Name of the lecturer	Dimitrios Kouzoudis
Learning outcome	By the end of this course the student will have acquired basic knowledge on fundamental concepts of: 1. Electromagnetism: Electric fields, Gauss law, Electric potential, dielectrics, current-resistance, Ohms law, circuits of continuum current, magnetic fields, Faraday's law, inductance, alternating current circuits, electromagnetic waves. and 2. Optics: Nature of light, geometrical optics, interference and diffraction of light.
Competences	By the end of this course the student will have developed the following skills: 1. Ability to learn and understand fundamental concepts of electromagnetism and optics. 2. Ability to use this knowledge and solve complicated physical problems. 3. Ability to deal with unknown problems and solve them. 4. Ability to collaborate with others for the solution of scientifically oriented problems.
Prerequisites	There are no prerequisites.
Course contents	1. Electric fields 2. Gauss law 3. Electric potential 4. Capacity and dielectrics 5. Current and resistance 6. Circuits of continuum current 7. Magnetic fields 8. Sources of magnetic fields 9. Faraday's law 10. Inductance 11. Alternating current circuits 12. Electromagnetic waves 13. Nature of light 14. Geometric optics 15. Interference of light 16. Diffraction of light
Suggested reading	• "Physics for scientists and engineers", R.A. Serway, part II and III • "Physics", D. Halliday and R. Resnick", part II • University Physics, Young Hugh D., Volume B
Teaching and learning methods	Presentation and tutorials aiming at the solution of complicated physical problems with the participation of the students.

Assessment and grading methods	Written final exam at the end of each semester. Minimum passing grade 5.
Language of instruction	Greek
Course URL	

Physics Laboratory

Course title	**Physics Laboratory**
Course code	**CHM_232**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	1st
Semester	2nd
ECTS credits	3
Name of the lecturer	Stella Kennou –Dimitris Kouzoudes
Learning outcome	To be familiar with simple scientific instruments and understanding of basic physics principles.
Competences/Skills	Operation of simple scientific instruments, analysis of experimental data and writing reports
Prerequisites	Knowledge of general physics (Mechanical, Electromagnetism, Optics, Heat and Temperature)
Course contents	Experimental Error sand statistical analysis, Experimental data in graphs and determination of mathematical relations Laboratory experiments in: **Mechanics** Measurements of basic constants– Measurement of g Uniformly accelerated linear motion Moment of inertia and angular acceleration **Optics** Diffraction from sing and double slit **Electricity, Electromagnetism and Electrodynamics** R-L-C Circuit, in series and in parallel , Resonance Charging and de-charging curve of a capacitor Capacitor in AC circuit - oscilloscope **Heat** Measurement of Temperature- Solar Cells
Suggested reading	Notes: Physics laboratory (S. Kennou, S. Brosda and A. Kalampounias) (in Greek) University Physics, e,g. H. Yiang, Serway

Teaching and learning methods	Groups of 3 students per laboratory experiment and individual written reports per experiment, teaching for the exploitation of the experimental results and their presentation
Assessment and grading methods	Final individual oral exams in the laboratory and the grades from the reports
Language of instruction	Greek
Course URL	https://eclass.upatras.gr/

Introduction to Science Education

Course title	**Introduction to Science Education**
Course code	**CHM_285**
Type of course	Elective
Level of course	Undergraduate
Year of study	1st
Semester	2nd
ECTS credits	3
Name of lecturer	D. Koliopoulos (Department of Educational Sciences and Early Childhood Education)
Learning outcomes	Knowledge of basic concepts of Science Education. Applications for the classroom.
Competences	At the end of this course the student is expected to develop the following competences: 1. Be able to use the basic concepts to design science lessons. 2. Be able to analyze teaching materials.
Prerequisites	Basic pedagogical knowledge. Basic knowledge of psychology of learning.
Course contents (analytic description & key-words, basic terns)	The epistemological framework of Science Education. Teaching of Physical Sciences. Fundamental questions. The concept of Didactic Contract. The concept of Didactic Transposition. The mental representations to the teaching of Physical Sciences. **Key words**: Science Education, teaching Sciences, Didactic Contract, Didactic Transposition, mental representations.
Recommended reading	Driver, R., Squires, A., Rushworth, P. & Wood-Robinson, V. (1994). Making sense of secondary science research into children's ideas. Routledge, London & New York. Johsua, S. & Dupin, J.J. (1993). Introduction à la didactique des sciences et des mathématiques. PUF, Paris.

Teaching and learning methods	Lectures using slides (MS PowerPoint) combined with standard class teaching, mainly for solving of problems to consolidate the theoretical knowledge. Homework exercises or/and a small project. The latter involves, among others, literature search.
Assessment and grading methods	Final written exam. The written exams comprise mainly theoretical questions but also solving of simple exercises.
Language of instruction	Greek
Course URL	

Philosophy of Science

Course title	**Philosophy of Science**
Course code	**CHM_286**
Type of course	Elective
Level of course	Undergraduate
Year of study	1st
Semester	2nd
ECTS credits	3
Name(s) of lecturer(s)	It will not be taught

English II

Course title	**English II**
Course code	**CHM_291**
Type of course	Elective
Level of course	Undergraduate
Year of study	1st
Semester	2nd
ECTS credits	3
Name(s) of lecturer(s)	Foreign Languages Teaching Unit

French II

Course title	**French II**
Course code	**CHM_292**
Type of course	Elective

Level of course	Undergraduate
Year of study	1st
Semester	2nd
ECTS credits	3
Name(s) of lecturer(s)	Foreign Languages Teaching Unit

German II

Course title	**German II**
Course code	**CHM_293**
Type of course	Elective
Level of course	Undergraduate
Year of study	1st
Semester	2nd
ECTS credits	3
Name(s) of lecturer(s)	Foreign Languages Teaching Unit

Italian II

Course title	Italian II
Course code	**CHM_294**
Type of course	**Elective**
Level of course	Undergraduate
Year of study	1st
Semester	2nd
ECTS credits	3
Name(s) of lecturer(s)	Foreign Languages Teaching Unit

Russian II

Course title	Russian II
Course code	**CHM_295**
Type of course	**Elective**
Level of course	Undergraduate
Year of study	1st
Semester	2nd

ECTS credits	3
Name(s) of lecturer(s)	Foreign Languages Teaching Unit

2nd Year – 3rd Semester

Mathematics III

Course title	**Ordinary Differential Equations**
Course code	**CHM_300**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	2nd
Semester	3rd
ECTS credits	6
Name of the lecturer	Spyros Pandis
Learning outcome	• Learning of the principles of solution of ordinary differential equations and their applications in engineering problems • Understanding of the behavior of the solutions of ordinary differential equations and their systems from the point of view of an engineer
Competences/Skills	In the end of the class the students should be able to: • Find general and particular solutions of first order differential equations. • Solve second order linear differential equations with constant coefficients • Use the method of power series for the solution of linear differential equations • Find and use appropriately the solutions of the Bessel and Legendre differential equations. • Use the Laplace transform and its inverse for the solution of ordinary differential equations • Solve linear systems of ordinary differential equations with constant coefficients • Investigate the qualitative behavior of the solution of a non-linear differential equation without solving it
Prerequisites	None
Course contents	Ordinary differential equations (DE) basic concepts and ideas. First order DE. Separable DE. Exact DE. Linear DE and Bernoulli equation. Homogeneous DE. Special forms of first order DE. Integrating factors. Linear DE of second order. Homogeneous linear equations of second order. Second-order

	homogeneous equations with constant coefficients. Non-homogeneous equations. Solution by undetermined coefficients. Solution by variation of parameters. Power series solution of differential equations. Legendre's equation. Frobenius method. Bessel's equation and Bessel functions. Laplace transforms and their properties. Transforms of special functions (step function, Dirac's delta function). Solution of DE by Laplace transform. Systems of DE. Transformation of higher order DE to a system of first order DE. Linear systems and the Wronski determinant. Homogeneous systems with constant coefficients. Graphical representation of solutions and the phase plane. Critical points and their stability. Qualitative solution of nonlinear systems of DE.
Suggested reading	• Δάσιος Γ., *Συνήθεις Διαφορικές Εξισώσεις*, Πάτρα, 1991. • Σταυρακάκης Ν., *Συνήθεις Διαφορικές Εξισώσεις*, Εκδ. Παπασωτηρίου, Αθήνα, 1997. • Τραχανάς Σ., *Συνήθεις Διαφορικές Εξισώσεις*, Παν. Εκδόσεις Κρήτης, Ηράκλειο, 2005. • Kreyszig E., *Advanced Engineering Mathematics*, 8th edition, Wiley, 1998. • Bronson R., *Εισαγωγή στις Διαφορικές Εξισώσεις*, McGraw Hill, ΕΣΠΙ, 1978. • Κρόκος Ι., *Διαφορικές Εξισώσεις*, Αρνος, 2005. • Greenberg M., *Advanced Engineering Mathematics*, 2nd Edition, Prentice Hall, 1998. • Zill, D. G., *Advanced Engineering Mathematics*, 3rd Edition, Jones & Burtlett, 2006. • Αλικάκος Ν. Δ. και Καλογερόπουλος Γ. Η., Συνήθεις διαφορικές εξισώσεις, Αθήνα Σύγχρονη Εκδοτική, 2003. • O'Neil P. V., *Advanced Engineering Mathematics*, 4th edition, Boston PWS, 1995. • Wylie C. R. and Barrett L. C., *Advanced Engineering Mathematics*, 6th edition, McGraw Hill, 1995.
Assessment and grading methods	The final grade is the grade of the final exam multiplied by a factor determined by a series of mini-tests (approximately 12) given during the semester. The factor varies from 1.0 for students that got no points in the tests to 1.30 for students that got 100 points or more. The tests last approximately 15 minutes and are given in the end of randomly selected classes. They involve the lecture that was just given and they are open-note. The solutions of the tests are discussed in the next lecture.
Language of instruction	Greek
Course URL	https://eclass.upatras.gr/courses/CMNG2174/

Organic Chemistry Laboratory

Course title	**Organic Chemistry Laboratory**
Course code	**CHM_311**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	2nd
Semester	3rd
ECTS credits	3
Name of the lecturer	C. Tsitsilianis
Learning outcome	Completing this laboratory course, the student should be able to organize and perform the synthesis of simple organic molecules. In particular he should be able to : 1) Collect all the necessary information (hazards, chemical properties of the compounds, bibliography of synthesis). 2) Explain the chemical role of the reagents. 3) Assembly all type of equipment necessary in classical organic synthesis. Accordingly the student should perform successfully the synthesis as well as the isolation and purification of the products. 4) In order to accomplish these tasks, he should know the various techniques used in organic synthesis such as extraction, filtration, distillation, re-crystallization etc. 5) Process the data and present the results of his experiments (yields, notes, improvements etc.)
Competences/Skills	Completing this laboratory course, the student should be able to : 1) Understand and perform various techniques in simple organic synthesis. 2) Be familiar with the various glassware necessary for the experiments. 3) Assemble the equipment necessary for the isolation and purification of the final organic product.
Prerequisites	There are not prerequisite courses formally. It is however advisable thatstudents should have basic knowledge in Organic Chemistry.
Course contents	1) Synthesis of acetanilide 2) Synthesis of tert- boutylchloride 3) Nitration of acetanilide 4) The Cannizzaro reaction 5) The Claisen- Schmidt reaction 6) Synthesis of oxime of cyclohaxanone 7) Thin Layer Chromatography (TLC)
Suggested reading	1. Notes: “Organic Chemistry Laboratory”(in Greek) 2. D.L. Paiva, G.M. Lampman and G.S. Kriz "Introduction to Organic Laboratory Techniques" New York (1998).

	3. M. Harwood, C.J. Moody and J.M. Percy "Experimental Organic Chemistry ", London (1995). 4. D. Papaioannou, G. Stavropoulos, T. Tsegenidis, “Introduction to Experimental Organic Chemistry, University of Patras Publications, Patras (1996), in Greek
Teaching and learning methods	Demonstration, using power point, of the various techniques in the organic synthesis as well as the theoretical background of the day’s experiment. Execution of 7 experiments, during which the students perform each on their own.
Assessment and grading methods	1) Written test before performing the day’s experiment (25% of the final grade). 2) Lab report (25% of the final grade). 3) Final written examination (50% of the final grade)
Language of instruction	Greek
Course URL	

Thermodynamics I

Course title	**Thermodynamics I**
Course code	**CHM_220**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	2nd
Semester	3rd
ECTS credits	7
Name of the lecturer	Soghomon Boghosian
Learning outcome	At the end of this course the student should be able to: 1) describe the foundations and the basic concepts of Thermodynamics; write and derive the Laws of Thermodynamics 2) comprehend the derivation of Thermodynamics through the Fundamental Equation, the Laws as well as through the appropriate mathematic tools 3) elaborate simple case studies, such as calculations of changes in thermodynamic properties in simple processes 4) describe phase transitions, by comprehending concepts such as the latent heat and the vapor pressure and performing pertinent calculations
Competences/Skills	Expected skills/competences possessed by students: 1) ability to use mathematic tools for deriving Thermodynamics through introduction of new functions and through correlations using partial derivatives

	2) performing calculations of changes in thermodynamic functions, work and heat in simple (non-chemical) processes 3) performing technical calculations in processes involving phase transitions
Prerequisites	The concept of prerequisite courses is not applied. The students are expected to have a good command of differential equations and simple integrals.
Course contents	FOUNDATION OF THERMODYNAMICS. Definitions and concepts. Thermodynamic systems and variables. Zeroth Law and temperature. Work. Internal Energy and First Law. Heat. The 1st Law in differential form. Spontaneous and non-spontaneous processes. The Entropy and the Second Law. Reversibility. Changes in Entropy of the system and the environment. Clausius inequality. Fundamental thermodynamic equation in internal energy representation. Cyclic processes. Legendre transformations and introduction of new thermodynamic functions. Enthalpy, Helmholtz free energy, Gibbs free energy. Chemical potential. Euler's theorem, Maxwell relations. Absolute entropy and 3rd Law. Cryogenic temperatures. THERMODYNAMIC PROPERTIES OF PURE HOMOGENIOUS COMPONENTS. Expression of thermodynamic properties through partial derivatives of thermodynamic functions. Specific heat. Thermal capacity at constant volume and at constant pressure. Calculations of changes in thermodynamic functions for pure substances. Equations of state of gases. Fugacity. Principle of corresponding states. Critical conditions. Reduced variables. PHASE EQUILIBRIA IN SINGLE COMPONENT SYSTEMS. Molar properties. Molar Gibbs free energy. Phase Rule. Thermodynamics of phase transitions. Vapor pressure. Clausius-Clapeyron equation. Antoine equation. Entropy and enthalpy changes of phase transitions. First and second order transitions. Lambda transitions. THERMODYNAMICS IN OPEN (FLOW) SYSTEMS. Generalized mass balances. Relation to thermodynamic laws. Applications of mass balances in simple systems of ideal gases.
Suggested reading	1) J. M. Smith, H. Van Ness, M. M. Abbott, «Introduction to Chemical Engineering Thermodynamics» (translated in Greek), A. Tziola & Sons Editions, 2011. 2) A. Papaioannou, «Thermodynamics– Volume I», Gelbesi Editions, 2007. 3) P. Atkins, J. de Paula, "ATKINS' Physical Chemistry", 8th Edition, Oxford University Press, 2006. 4) K. Denbigh, "The Principles of Chemical Equilibrium", Cambridge University Press, 1957

Teaching and learning methods	Standard class teaching. Periodically, review crash courses are given in seminar form using power point.
Assessment and grading methods	1) The students can take two (2) tests on volunteer basis, during the 6th and 13th week of the semester. 2) Undertaking of case studies/projects by small (3, 4) student groups, on volunteer basis. The study involves *inter alia* bibliographic research. 3) Final exam. The average of the exams (1) – if greater than 5.0 – is considered together with the (optional) project (2) for improving the final course grade.
Language of instruction	Greek
Course URL	

Computer Programming for Chemical Engineers

Course title	**Computer Programming for Chemical Engineers**
Course code	**CHM_363**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	2nd
Semester	3rd
ECTS credits	7
Name of the lecturer	Dimitrios S. Mataras
Learning outcome	A) Basic algorithm programming skills. B) Familiarization with basic and advanced programming techniques: from structured to procedural and object oriented programming. C) Preparation for modern arithmetic analysis problem solving.
Competences/Skills	A) Hierarchical logic programming of basic chemical engineering problem solving steps. B) Computing competence at a level beyond the user of simple ready-made applications. C) Using modern IDE for developing and debugging applications. D) Data visualization.
Prerequisites	It is preferable that students have followed the lyceum course ‘Application Development in a Programming Environment’ or the first year elective ChE162 ‘Introduction to Computers’.
Course contents	Computer Programming and Chemical Engineering. Algorithms: categories, data structures, design techniques, performance analysis. Elements of Fortran 95/2003/2008. Basic data types, expressions and statements, operator and data type

	precedence. Flow control structures: conditional branching, case selection, iterative and conditional loops. Input-output statements, file handling. Arrays: elements and sectors, array constructors, subscript triplets, vector subscripts, implied loops. Parallel structures (where, forall). Internal procedures: functions, subroutines, recursive procedures. Dynamic Data Structures: dynamic arrays, assumed shape and automatic arrays, pointers, lists. Derived data types. Modules: module procedures, data range and association, procedure interfaces, user defined and overloaded operators. Object Oriented Programming: encapsulation, polymorphism, inheritance. Basic algorithm examples: search and sort, random numbers, equation solving, data visualization. **Keywords:** Computer Programming, Algorithms, Fortran 2008
Suggested reading	1. Fortran 95/2003 for Scientists and Engineers (3rd edition) (In English). S. J. Chapman. McGraw Hill 2008. 978-0-07-319157-7 2. Programming Fortran 90/95 for Scientists and Engineers (In Greek). D. S. Mataras, F. A. Coutelieris. Tziolas Publishing 2001, ISBN 960-6219-43-X 3. Introduction to Fortran 90 (In Greek). L. Nyhoff, S. Leestma. ION publishing 2004. ISBN 960-411-492-1 4. eclass materials: Lecture presentations, Solved lab, homework and past exam subjects.
Teaching and learning methods	Includes 4 hr/week lectures using computer presentation, 3 hr/week computer lab (1 computer/student). In addition students have to deliver 8 homework papers via eclass. Instructor accessible for at least 2 hr/week for office consultation or anytime through eclass/email.
Assessment and grading methods	A. Weekly lab/eclass evaluation B. Written examination
Language of instruction	Greek
Course URL	https://eclass.upatras.gr/courses/CMNG2102/ only for registered users

Physical Chemistry

Course title	**Physical Chemistry**
Course code	**CHM_421**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	2^{nd}
Semester	3^{rd}

ECTS credits	7
Name of the lecturer	Dimitris Kondarides –Alexandros Katsaounis
Learning outcome	After completing this course a student should be able to: 1. Understand the fundamental concepts of quantum mechanics, such as the Schrödinger equation, wave function and its physical interpretation, quantization, and expectation values. 2. Understand the quantum mechanical description of a particle’s translational, rotational and vibrational motions and discuss the corresponding wavefunctions and energy levels. 3. Grasp the concepts of spin and angular momentum and their quantization, and explain the Zeeman affect and spin-orbit coupling. 4. Understand how quantum mechanics can be used to describe the electronic structure of hydrogenic atoms and many-electron atoms. 5. Demonstrate knowledge of basic concepts of the molecular orbital approximation, and the methods that can be used to describe the structures of diatomic and polyatomic molecules. 6. Understand the origin of atomic and molecular spectra and discuss the selection rules governing such spectra. 7. Predict the thermodynamic properties of a gas in the ideal state from the knowledge of a few literature data for the vibrational frequencies and the geometry of the molecule 8. Apply principles of Statistical Thermodynamics in order to compute equilibrium constants for chemical reactions
Competences/Skills	At the end of the course the student will have further developed the following skills/competences: 1. Ability to solve the Schrödinger equation to obtain wave functions for some simple, physically important one-dimensional systems, and to apply the technique of separation of variables to solve problems in more than one dimension. 2. Ability to apply operators to the wavefunction to obtain information about a particle's physical properties such as position, momentum and energy. 3. Ability to determine the electronic structure of an atom according to the modern quantum theory and to relate it to its properties and interactions with light. 4. Ability to interpret atomic spectra. 5. Ability to interpret rotational and vibrational spectra of simple molecules and obtain information related to their physical properties. 6. Predict the thermodynamic properties of a gas in the ideal state from the knowledge of a few literature data for the vibrational frequencies and the geometry of the molecule

	7. Calculate the canonical partition function from the knowledge of the underlying interactions in the system, and from that to extract its thermodynamic properties 8. Apply principles of Statistical Thermodynamics in order to compute equilibrium constants for chemical reactions
Prerequisites	There are no prerequisite courses. The students are expected to master the basic mathematical skills that will be required throughout the course (use of complex numbers and functions, simple differential equations, integrals, and basic linear algebra).
Course contents	**Introduction to the Quantum Theory.** Classical mechanics. The dynamics of microscopic systems. Quantum mechanical principles. **Techniques and Applications.** Translational motion. Vibrational motion. Rotational motion. **Atomic Structure and Atomic Spectra.** The structure and spectra of hydrogenic atoms. The structures of many-electron atoms. The spectra of complex atoms. Term symbols and selection rules. The effects of magnetic fields. **Molecular Structure and Molecular Spectra.** Molecular orbital theory. The hydrogen molecule-ion. The structures of diatomic molecules. The structures of polyatomic molecules. Rotational spectra of diatomic and polyatomic molecules. Vibrational spectra of diatomic molecules. Introduction to electronic transitions and electronic spectra. **Introduction to statistical thermodynamics.** Basic concepts, overall goal. Thermodynamic equilibrium. Equilibrium statistical ensembles. **Canonical partition function.** Boltzmann distribution. Canonical statistical ensemble and applications in thermodynamics. Translational, rotational, vibrational, and electronic contributions to the molecular canonical partition function. Fluctuations. 3rd thermodynamic law and residual entropies **Calculation of the equilibrium constants for chemical reactions.** Application to dissociation reactions.
Suggested reading	1. P.W. Atkins and J. de Paula, “Physical Chemistry”, 9th Edition, Oxford University Press, 2010. 2. V.G. Mavrantzas, “Statistical Thermodynamics” (in Greek), book for the course on “Physical Chemistry”, Studies in Natural Sciences, Hellenic Open University, Patras (2001). 3. D.A. McQuarrie, J.D. Simon, “Physical Chemistry: A Molecular Approach”, University Science Books, Sausalito, California, 1997. 4. H. Kuhn, H.-D. Forsterling, D.H. Waldeck, “Principles of Physical Chemistry”, 2nd Edition, John Wiley & Sons, Inc., 2000.

Teaching and learning methods	Lectures (PowerPoint presentations). Lectures notes and other didactic material are made available to the students in electronic format.
Assessment and grading methods	Written examination
Language of instruction	Greek
Course URL	

2nd Year – 4th Semester

Partial Differential Equations

Course title	**Partial Differential Equations**
Course code	**CHM_402**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	2nd
Semester	4th
ECTS credits	4
Name of the lecturer	Spyros Pandis
Learning outcome	• Learning of the principles of solution of partial differential equations (PDEs), the principles of probability theory and statistics, and their application in engineering problems • Understanding of the behavior of the solutions of PDEs with emphasis on the equations studied (heat transfer, wave, etc.)
Competences/Skills	In the end of the class students should be able to: • Find general solutions of PDEs using the separation of variables. • Apply the problem boundary and initial conditions using Fourier and other series. • Find solutions of PDEs using the Laplace transform
Prerequisites	None
Course contents	Partial differential equations (PDE) and their solutions. Basic concepts. Solution of PDEs by separation of variables. Fourier series and PDEs. Even, odd and non-periodic functions. One-dimensional wave equation. One-dimensional heat transfer equation. Boundary value problems. Heat transfer in two dimensions. Two-dimensional wave equation-polar coordinates. Solution of PDEs by Laplace transforms. Sturm-Liouville prolems. Solution of PDEs with non-homogeneous boundary conditions.

Suggested reading	• Τραχανάς Σ. (2007) *Μερικές Διαφορικές Εξισώσεις*, Παν. Εκδόσεις Κρήτης, Ηράκλειο. • Δάσιος Γ. και Κ. Κυριακή (1994) *Μερικές Διαφορικές Εξισώσεις*, Πάτρα, 1994. • Kreyszig E., *Advanced Engineering Mathematics*, 8th edition, Wiley, 1998. • Greenberg M., *Advanced Engineering Mathematics*, 2nd Edition, Prentice Hall, 1998. • Zill, D. G., *Advanced Engineering Mathematics*, 3rd Edition, Jones & Burtlett, 2006. • O'Neil P. V., *Advanced Engineering Mathematics*, 4th edition, Boston PWS, 1995. • Wylie C. R. and Barrett L. C., *Advanced Engineering Mathematics*, 6th edition, McGraw Hill, 1995.
Assessment and grading methods	The final grade is the grade of the final exam multiplied by a factor determined by a series of mini-tests (approximately 12) given during the semester. The factor varies from 1.0 for students that got no points in the tests to 1.30 for students that got 100 points or more. The tests last approximately 15 minutes and are given in the end of randomly selected classes. They involve the lecture that was just given and they are open-note. The solutions of the tests are discussed in the next lecture.
Language of instruction	Greek
Course URL	https://eclass.upatras.gr/courses/CMNG2175/

Physical Chemistry Laboratory

Course title	**Laboratory Physical Chemistry**
Course code	**CHM_521**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	2nd
Semester	4th
ECTS credits	3
Names of the lecturers	Soghomon Boghosian Alexandros Katsaounis
Learning outcome	By accomplishing a successful participation in this laboratory course the student should be able to: 1. have been acquainted with the basic applications of Electrochemistry (Exercises 1–3) by comprehending the concepts of conductivity, equivalent conductivity, ionic mobility, transport number and electromotive force (emf)

	2. to have comprehended a spectroscopic method of quantitative analysis (Exercise 4) 3. to understand the importance of the deviation (as well as of the type of deviation) of a gas from ideal behavior through a specific application (Exercise 5) 4. to comprehend through specific practical applications the behavior of non ideal solutions of volatile liquids and solutions of solids (molecular and ionic) in liquid solvents (Exercises 6–8)
Competences/Skills	Expected skills/competences possessed by students: 1. ability to perform experimental measurements with precision 2. competence in elaborating experimental data based on pertinent theoretical principles 3. competence in producing technical reports with conclusions based on elaboration of experimental measurements
Prerequisites	The concept of prerequisite courses is not applied. The students are expected to have a good command of the pertinent theoretical background of Chemical Thermodynamics and Physical Chemistry.
Course contents	Laboratory exercises of Physical Chemistry: 1. *Conductometric titrations*. Conductivity mechanisms in ionic solutions. Conductivity and equivalent conductivity. 2. *Electrochemical Analysis*. Electrochemical reaction. Electrochemical cell. Electrolysis. 3. *Determination of diffusion potential*. Ionic mobilities. Transport numbers. Galvanic cells. Nernst equation. 4. *Ultraviolet-Visible Spectrophotometry (UV/VIS)*. Electronic absorption spectra. Beer-Lambert law. Molar extinction coefficient. 5. JOULE-THOMSON expansion. Real (non-ideal) gases. Liquification. Cryogenics. 6. *Vapor-Liquid equilibria*. Raoult law. Ideal and non-ideal solutions of volatile liquids. Azeotropic composition. 7. *Freezing point depression*. Equilibrium between a solution and a solid component. Determination of molar mass of unknown component. 8. *Partial molar volumes*. Non ideal solutions. Significance and determination of partial molar properties
Suggested reading	1. P. Atkins, J. de Paula, “ATKINS’ Physical Chemistry”, 8th Edition, Oxford University Press, 2006. 2. K. Denbigh, “The Principles of Chemical Equilibrium”, Cambridge University Press, 1957.
Teaching and learning methods	a) Seminars using power point introducing the theoretical background of the laboratory exercises as well as outline

	descriptions of the experimental methodology for each exercise. b) Performing experiments in small groups (3,4) of students. c) Report writing
Assessment and grading methods	1. Two (2) mandatory tests, during the 6th and 13th week of the semester. 2. Oral interview while performing of the laboratory experiment. 3. Evaluation of the written report. The above contribute to the final grade in 50, 10 and 40% proportions, respectively.
Language of instruction	Greek
Course URL	

Numerical Analysis

Course title	**Numerical Analysis**
Course code	**CHM_660**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	2nd
Semester	4th
ECTS credits	8
Names of the lecturer	Yannis Dimakopoulos
Learning outcome	This course introduces students to a variety of numerical methods and then applies these methods to solve a broad range of scientific problems. These problems include examples from physics as well as several other disciplines, including reaction engineering, unit operations, transport phenomena and physical chemistry. Numerical techniques for solving problems expressed in terms of matrix, differential and integral equations will be developed. The course material and presentation will accommodate a range of scientific backgrounds. At the end of this course the student should have a good insight of the numerical methods and must be able to apply them in Engineering problems.
Competences/Skills	At the end of the course the student will have further developed the following skills/competences: 1. Ability for deep understanding of the fundamental numerical methods.

	2. Ability to recognize the advantages and disadvantages of each method in order to decide the most convenient in use on application basis. 3. Ability to use specific software in order to develop the necessary applications. 4. Ability to analyze and interpret data
Prerequisites	There are no prerequisite courses. It is, however, recommended that students should have a good knowledge of Mathematics (Calculus, Linear Algebra, Differential Equations) as well as fundamental skills on Scientific Programming.
Course contents	Introduction (discretization, error analysis), Numerical Differentiation (forward, backward and central differences), Numerical Integration (trapezoid rule, Simpson rule, Newton-Cotes formulae), Interpolation/Extrapolation (Taylor, Lagrange polynomials), Numerical solution of algebraic equations (trial & error, bisection, Newton-Raphson), Numerical solution of linear systems (Gauss, Jacobi, Gauss-Seidel), Numerical Integration of Ordinary Differential Equations (Euler, Runge-Kutta), Finite Differences, Special Topics, Non-linear systems.
Suggested reading	1. Chapra S. & Canale R., "Numerical Methods for Engineers" (6^{th} ed.), McGraw-Hill (2012) 2. Pozrikidis C., "Numerical Computation in Science and Engineering", Oxford University Press, New York (1998). 3. Daoutidis P., Mastrogeorgopoulos, S. & Sidiropoulou, E. "Numerical Methods for engineering problems", Anikoula Ed., Thessaloniki (2010), in Greek. 4. Burden R.L., Faires, J.D., Numerical Analysis, 9^{th} edition, Cengage Learning (2010).
Teaching and learning methods	Lectures using multimedia presentations. Training in the Lab using programming techniques and codes for problem-solving.
Assessment and grading methods	1. Laboratory problem-solving by the students (35% of the final grade). 2. Written examination (open-book, 65% of the final grade).
Language of instruction	Greek
Course URL	https://eclass.upatras.gr/courses/CMNG2136/index.php

Thermodynamics II

Course title	**Thermodynamics II**
Course code	**CHM_320**
Type of course	Compulsory
Level of course	Undergraduate

Year of study	2^{nd}
Semester	4^{th}
ECTS credits	7
Names of the lecturer	Soghomon Boghosian
Learning outcome	At the end of this course the student should be able to: 1. differentiate between molar and partial molar properties; describe the equations of formalism for gas mixtures (ideal and real); 2. recite and describe the Thermodynamics of gaseous reactions with emphasis in the general condition of equilibrium, the equilibrium constant, the standard thermodynamic functions of the reaction, the standard thermodynamic functions of formation of components, the T–dependence of the equilibrium constant and the maximum attainable yield 3. comprehend the thermodynamics of solution by differentiating between ideal and non-ideal solutions and understand the pertinent differences among the respective chemical potential models
Competences/Skills	Expected skills/competences possessed by students: 1. Performing calculations on gas mixture systems 2. Ability to calculate equilibrium compositions, thermodynamic functions and reaction conditions using data from Thermochemical Tables 3. Skill in constructing partial pressure-composition diagrams in binary liquid/gas systems and performing pertinent calculations as well as in performing calculations and solving problems in cryoscopic, zeseoskopic and osmotic pressure systems
Prerequisites	The concept of prerequisite courses is not applied. The students are expected to have a good command of differential equations and simple integrals, as well as basic knowledge of chemistry.
Course contents	Partial molar properties and their calculation. Gibbs-Duhem equations. Ideal and real gas mixtures. Lewis-Randall rule. Equilibria of reactions involving gases. Stoichiometry. Direction and extent of reaction. General condition of equilibrium. Equilibrium constant. Standard Gibbs free energy of reaction. Temperature dependence of the equilibrium constant. Van't Hoff relation. Enthalpy of reaction. General relations for the temperature dependence of K_p and ΔG_T^0. Van't Hoff plots. Other forms of the equilibrium constant. Standard thermodynamic functions (G, H, S) of formation. Hess' Law. Reaction equilibria involving gases together with immiscible liquids and solids. Number of independent reactions. General remarks on maximum attainable yield. Le Chatelier's principle.

	Gibbs' Phase Rule. Additional restrictions and degrees of freedom. Effect of inert gas on the vapor pressure of a component. General properties of solution. Gibbs-Duhem equation. Partial pressure – composition relations. Raoult's and Henry's Law. Deviations. Duhem-Margules equation. Application of the Gibbs-Duhem equation to the total pressure curve. Solubility, molecular approach. Ideal solutions. The chemical potential model for ideal solutions. Thermodynamic properties of mixing in ideal solutions. Temperature and pressure dependence of the Henry's law constant. Equilibrium between ideal solution and pure crystalline component. Freezing point depression. Boiling point elevation. Osmotic pressure. Non ideal solutions and the chemical potential model. Activity coefficients. Determination of activity coefficients. Gibbs – Duhem equation in representation of activity coefficients. Activity coefficients of solutes. Activity. Excess properties.
Suggested reading	1. P. Atkins, «Physical Chemistry, Vol. I» (in Greek), University of Crete Editions, 2010. 2. Y. A. Cengel and M. A. Boles "Thermodynamics: An Engineering Approach" 6th Ed., McGraw Hill, 2007. 3. P. Atkins, J. de Paula, "ATKINS' Physical Chemistry", 8th Edition, Oxford University Press, 2006. 4. K. Denbigh, "The Principles of Chemical Equilibrium", Cambridge University Press, 1957.
Teaching and learning methods	Standard class teaching. Periodically, review crash courses are given in seminar form using power point.
Assessment and grading methods	1. Two tests on volunteer basis, 6th and 13th week. 2. Projects by small (3,4) student groups, on volunteer basis. The study involves *inter alia* literature research. 3. Final exam. The average of the tests (1) – if greater than 5.0 – is considered together with the (optional) project (2) for improving the final course grade.
Language of instruction	Greek
Course URL	

Mechanics of Materials

Course title	**Mechanics of Materials**
Course code	**CHM_582**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	2nd

Semester	4th
ECTS credits	5
Name of the lecturer	Costas Galiotis
Learning outcome	After completing this course a student should be able to: - Understand the concepts and principles applied to members under various loadings and the effects of these loadings. - Analyze structural members subjected to tension, compression, torsion, bending and combined stresses using the fundamental concepts of stress, strain and elastic behavior of materials. - Analyze cylindrical vessels subjected to pressure.
Competences/Skills	At the end of the course the student will have further developed the following skills/competences: - Be able to conduct professionally and with regard to their responsibilities toward society - Be able to design in an effective way engineering parts and structures to prevent failure. - Be able to determine the stresses, strains and deflections in various members produced by applied loading.
Prerequisites	Students should have knowledge of mathematics and physics.
Course contents	**A. ELEMENTS OF STATICS (Non-Deformable Bodies)** **1. Introduction.** Forces. Forces synthesis and equilibrium. Torque. Solid body balance and equilibrium equations. **2. Trusses.** Elements of vector analysis. Working with vectors. Trusses. Statically Indeterminate truss **3. Diagrams N, Q, M.** Type of vectors and methods of joint. Beam Stress state. Uniaxial - Shear. **B. STRENGTH OF MATERIALS (Deformable Bodies)** **4. Introduction in strength of materials.** Axial, plane, general stresses. Hooke's Law. Generalized Hooke's law. Superposition principle. Shear. Thermal stresses. Static problems.Mechanical behaviour of metals, ceramics and polymers. **5. Fracture, Plastic Yielding and Fatigue of Materials** Failure in tension and compression. General principles of fracture mechanics. Plastic yielding. Models of yielding. Fatigue of materials. Models describing fatigue behaviour. **6. Thermal stresses and strains** Thermal effects. Volumetric change under axial loading. Thermal expansion and calculation of stresses in various temperatures. **7. Bending and Torsion** **8.** Axial loading and Bending. Geometric centres, moment of inertia. Bending. Maximum hoop stress. Beam dimensioning during bending. Shear-bending. Axial

	loading and Torsion.Torsion of thin-walled vessels. Torsion of round sectional bar. Static problems of torsion. **9. <u>Thin-walled pressure vessels</u>** Stresses and deformations. Failure. Volumetric behaviour. Design problems. **Keywords**: trusses, forces, diagrams N, Q, M, shear, thermal stresses, Hooke Law, thin-walled tubes, torque, torsion, bending
Suggested reading	P.A. Vouthounis, Technical Mechanics, Edit. 2011. ISBN: 978-960-85431-7-1 F.P. Beer, E.R. Johnston,Jr, J.T. DeWolf, D.F. Mazurek, Edit. Tziola, 2012. ISBN: 978-960-418-381-4
Teaching and learning methods	Lectures, Training in solving exercises
Assessment and grading methods	Non-compulsory progress exams or final written examination (100% of the final mark)
Language of instruction	Greek
Course URL	http://www.chemeng.upatras.gr/en/content/courses/en/mechanics-materials

Statistics for Engineers

Course title	**Statistics for Engineers**
Course code	**CHM_202**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	2nd
Semester	4th
ECTS credits	3
Name of the lecturer	Spyros Pandis
Learning outcome	Learning of the principles of probability theory and statistics, and their application in engineering problems
Competences/Skills	In the end of the class students should be able to: • Use the basic principles and theorems of probability theory and combinatorial analysis. • Use probability distributions for discrete and continuous random variables. • Solve engineering problems using the normal distribution. • Estimate confidence intervals for the mean and the standard deviation of a random variable • Test hypotheses

	• Perform linear regression of data using the least squares method and to estimate the corresponding confidence intervals
Prerequisites	None
Course contents	Data analysis. Probability theory and the definition of probability. Basic theorems of probability theory. Permutations and combinations. Discrete random variables and their probability distributions. Continuous random variables. Parameters of probability distributions. Normal distribution. Binomial, hypergeometric and Poisson distributions. Estimation of parameters. Confidence intervals. The t- and χ^2-distributions. Testing of hypotheses. Regression analysis. Correlation analysis.
Suggested reading	• Ζιούτας Γ. (2004) *Πιθανότητες και Στοιχεία Στατιστικής για Μηχανικούς*, Εκδ. Ζήτη, Θεσ/νίκη. • Kreyszig E., *Advanced Engineering Mathematics*, 8th edition, Wiley, 1998. • Greenberg M., *Advanced Engineering Mathematics*, 2nd Edition, Prentice Hall, 1998. • Zill, D. G., *Advanced Engineering Mathematics*, 3rd Edition, Jones & Burtlett, 2006. • O'Neil P. V., *Advanced Engineering Mathematics*, 4th edition, Boston PWS, 1995. • Wylie C. R. and Barrett L. C., *Advanced Engineering Mathematics*, 6th edition, McGraw Hill, 1995.
Assessment and grading methods	The final grade is the grade of the final exam multiplied by a factor determined by a series of mini-tests (approximately 12) given during the semester. The factor varies from 1.0 for students that got no points in the tests to 1.30 for students that got 100 points or more. The tests last approximately 15 minutes and are given in the end of randomly selected classes. They involve the lecture that was just given and they are open-note. The solutions of the tests are discussed in the next lecture.
Language of instruction	Greek
Course URL	https://eclass.upatras.gr/courses/CMNG2176/

3rd Year – 5th Semester

Fluid Mechanics

Course title	**Fluid Mechanics**
Course code	**CHM_550**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	3rd
Semester	5th
ECTS credits	6
Names of the lecturer	Yiannis Dimakopoulos
Learning outcome	In the end of the course, the student should understand: 1. The basics of fluid flow and how to develop micro- & macro-scopic mass & momentum balances. 2. The concept of the stress tensor and how to use it to compute the applied forces. 3. The physical significance & importance of the relevant dimensionless numbers to solve problems.
Competences/Skills	The student will have developed the following skills: 1. Be able to simplify complex flow phenomena to simpler ones and solve the latter in simple geometries for Newtonian fluids. 2. Develop and simplify mass and momentum balances, determine the relevant auxiliary conditions and solve the resulting equations. 3. Understand the difference between creeping, laminar, turbulent and boundary layer flow. The required in each one simplifications and the procedure to solve the corresponding problems.
Prerequisites	Prerequisite courses have not been set. The students however, must have good knowledge of Differential and Integral calculus of methods to solve Differential equations.
Course contents	INTRODUCTION. Definitions. Continuum hypothesis. Laws for solving flow problems. System and control volume. Newtonian and non-Newtonian fluids. FLUID STATICS. Differential equations of linear momentum for static fluids. Manometers. Hydrostatic forces. Buoyancy. STEADY, LAMINAR, 1D FLOWS. Analysis based on differential material and control volume. Examples with Newtonian fluids. KINEMATICS. Material and spatial coordinates. Time derivatives (partial, total, material). Velocity & acceleration. Transport theorem by Reynolds. Relation between closed

	system & control volume. Macroscopic mass balance. Stream & streak lines, stream function. MACROSCOPIC BALANCES. Linear momentum and energy balance. Angular momentum balance. STRESS TENSOR. Point stress. Total and extra stress tensors and their symmetry. Cauchy equation of motion. RHEOLOGICAL EQS. Rate of strain tensor. Newton's law of viscosity. Dynamic and kinematic viscosity Non- Newtonian behavior. THE NAVIER-STOKES EQS. Development of the NS eqs. Dimensionless form. The Reynolds and Froude numbers. Ideal flow, Euler and Bernoulli eqs. Dynamic flow. Creeping flow. Stokes equation Incompressible, 2D flow based on the stream function. Flow around a sphere. STEADY. LAMINAR, 1D FLOWS, REVISETED. Examples with Newtonian and non-Newtonian fluids. BOUNDARY LAYERS. Flow equations in a boundary layer. Exact and approximate solution. Detachment.
Suggested reading	**Course textbook** "Fluid Mechanics", A. Payatakes, Editions of the Univ. of Patras (in Greek) **Books for additional studying** 1. Introduction to Fluid Mechanics, Whitaker, 1981, Krieger 2. Introduction to Fluid Mechanics, 8th Ed., Fox R.W., McDonald A.T., 2012, Wiley 3. "Fluid Mechanics" Vol. I και II, Papaioannou, A., 2002, Korali Ed. (in Greek) 4. "Transport Phenomena", Revised 2nd Ed., Bird R.B., Stewart W.E., Lightfoot E.N. 2007, Wiley 5. "Fundamentals of Momentum, Heat and Mass Transfer", Welty, Wicks, Wilson, 1984, Wiley 6. "Multimedia Fluid Mechanics", CD-ROM, Homsy et al., 2000, Cambridge.
Teaching and learning methods	Besides the lectures, exercises to better understand the course content are presented in recitations. Additionally review exercises are given similar to those that have been given in past exams. The students are strongly encouraged to solve them before their presentation in special review lectures to maximize the benefit to them and better preparation for the final exam.
Assessment and grading methods	The course grade is determined by the final exam
Language of instruction	Greek
Course URL	

Polymer Science

Course title	**Polymer Science**
Course code	**CHM_570**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	3rd
Semester	5th
ECTS credits	5
Names of the lecturer	C. Tsitsilianis
Learning outcome	1. Be acquainted with the basic concept of polymer characterization. 2. Be acquainted with the chemistry of step-growth and chain-growth polymerization reactions. 3. Be able to extract the kinetic equations of the polymerization reactions. 4. Comprehend and use the basic principles of statistical thermodynamics of macromolecular solutions and distinguish them from those of small molecules. 5. Be acquainted with the basic principles concerning the various characterization techniques of polymers e.g. osmometry, viscometry and gel permeation chromatography. 6. Be acquainted with the states of polymers (amorphous, crystalline) and how they influence the ultimate properties in the solid state. Comprehend the relationship between the chain conformation and the thermal properties of polymers (T_g, T_m). 7. Understand the basic principles of polymer viscoelasticity to choose the appropriate method for the determination of mechanical properties of polymers.
Competences/Skills	1. Ability to use the basic concepts of polymer characterization. 2. Ability to design the polymerization reactions for th synthesis of polymers. 3. Ability to solve problems dealing with the kinetics of polymerization reactions. 4. Ability to correlate the thermodynamic parameters with practical problems like polymer solubility, fractionation etc. 5. Ability to use the knowledge dealing with the solid state of polymers for the understanding of their properties. 6. Ability to use the knowledge of physical chemistry of dilute macromolecular solutions in the polymer characterization techniques.
Prerequisites	There no prerequisite courses. It is, however, recommended that students should have at least basic knowledge of Organic Chemistry, Physical Chemistry and Thermodynamics.

Course contents	1. Introduction Nomenclature of macromolecules, degree of Polymerization, Average molecular weights, classification of polymerization reactions, macromolecular architecture, copolymers, isomerism of macromolecules. 2. Chemistry of step-growth polymerization Monomers and general schemes of step-growth reactions, polymers of high mechanical and thermal strength, crosslinked polymers (thermosettings), dendrimers. 3. Kinetics of step-growth polymerization Rate laws, relationship of degree of polymerization with stoichiometric imbalance of monomers, distribution of molecular sizes, kinetics of gelation reactions. 4. Chemistry of chain-growth radical polymerization The role of the monomer chemical structure, initiators, thermal catalysis, photochemical thermal and redox catalysis, reactivity of initiators, retarders and inhibitors of reactions, controlled free radical polymerization. 5. Kinetics of chain-growth polymerization Kinetic scheme (initiation, propagation, termination) polymerization rate, evaluation of kinetic constants, degree of polymerization of products DP_n, DP_w versus monomer conversion relationships, the Trommsdorff effect, influence of chain transfer reactions on the kinetic equation. 6. Kinetics of radical copolymerization Kinetic scheme, reactivity ratios, equation of copolymerization, ideal copolymerization, azeotropic copolymerization, alternating copolymerization, evaluation of reactivity ratios. 7. Statistical thermodynamics of macromolecular solutions Statistical thermodynamic concepts, (ideal, regular solutions), lattice model, Flory Huggins theory, entropy of mixing of athermal solutions, enthalpy of mixing and chemical potentials of regular solutions, thermodynamics of real polymer solutions the interaction parameter. 8. Phase equilibria, solubility Phase diagrams, polymer/solvent binary systems, polymer 1/polymer 2 binary systems (polymeric blends) 9. Dilute polymer solutions and characterization methods of polymers, osmotic pressure-determination of M_n, viscometry-determination of M_v, gel permeation chromatography-determination of average molecular weights and molecular weight distribution. 10. Solid state properties of macromolecules Crystallization state, factors that influence crystallinity, thermodynamics of polymer crystallization, kinetics of crystallization, melting, amorphous state, glass transition temperature, T_g, factors that influence T_g, free volume theory. 11. Mechanical properties

Suggested reading	1. "Synthetic Macromolecules", A. Dondos, Kostarakis Publ., Athens, 2012 (in Greek). 2. "Science and Technology of Polymers", K. Panagiotou, Pigasos Publ., Thessaloniki, 2005 (in Greek). 3. "Polymers: Chemistry Physics of modern materials" J.M.G. Cowie, 2nd Ed. Blakie London 1991. 4. "Polymer Chemistry" P.C.Hiemenz, T.P. Lodge 2nd Ed. CRC Press, New York 2007.
Teaching and learning methods	Lectures using Power Point presentation, Problem solving seminars.
Assessment and grading methods	Written assay after the completion of the first five chapters (for marks over 5 there is a bonus that will be added to the final exams mark with the prerequisite of minimum mark of 4 in the final written examination). Final written examination.
Language of instruction	Greek
Course URL	

Technical Thermodynamics and Balances

Course title	**Technical Thermodynamics and Balances**
Course code	**CHM_540**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	3d
Semester	5th
ECTS credits	6
Names of the lecturers	S. Ladas D. Spartinos
Learning outcome	**1.** Understanding the generalized Balance concept in Chemical Engineering processes for any physical quantity with measurable changes (like quantity of matter, energy, entropy) and familiarization with setting up and solving the respective Balances. **2.** Practice in finding material thermodynamic properties (like density, specific enthalpy and entropy, standard enthalpies of formation), necessary for solving the balances equations, using literature databases in the form of equations, charts and tables. **3**. Acquiring, via problem solving, of a broad picture from various processes and installations used in manufacturing chemical products, in efficient energy transformations and in environmental protection.

Competences/Skills	At the end of the course the student will have further developed the following skills/competences: **1.** Competence to assimilate concepts, principles and applications of generalized material, energy and entropy balances. **2.** Skill to locate/manipulate relevant databases (Tables, Charts) in order to obtain thermodynamic material properties. **3**. Competence to apply the acquired knowledge in solving diverse practical problems concerning Physical and Chemical Processes in Chemical Industry, as well as Energy Transformation Technologies.
Prerequisites	There are no formal prerequisites. Students are expected to have basic knowledge from Mathematics, General and Inorganic Chemistry, Organic Chemistry as well as Thermodynamics I & II courses.
Course contents	**1. Brief summary of the concept of Balances:** Importance of Balances for Chemical Engineers - Introduction to technical calculations. **2. Material Balances:** Applications in simple and complex systems with and without chemical reactions. Industrial applications (Recycle – Bypass - Purge). **3. Calculations of thermodynamic property changes:** Empirical equations of state. Multiparametric Corresponding States correlations (Lee-Kessler and Pitzer correlations - Nelson-Obert charts). Enthalpy and entropy change calculations from equations of state and specific heat data. Thermodynamic charts, Steam Tables. Calculating ΔH, ΔS using Corresponding States correlations to evaluate residual thermodynamic properties. **4**. **Material and Energy Balances:** Applications in systems with and without chemical reactions. **5. Combining material, energy and entropy balances. Thermodynamic process analysis:** Lost work and thermodynamic efficiency. Applications in energy generation, refrigeration, liquefaction, chemical processes.
Suggested reading	1. D.M.Himmelblau, J.B.Riggs, "Basic Principles and Calculations in Chemical Engineering", 7th Edition, (Transl. in Greek by G. Marnelos), Edit.Tziola (2006) 2. D.M.Himmelblau, "Basic Principles and Calculations in Chemical Engineering", 3d Edition (Transl. and Edit. in Greek by G.P. Sakellaropoulos) (1982) 3. J.M.Smith , H.C. van Ness, M.M. Abbott "Introduction to Chemical Engineering Thermodynamics", 7th Edition in SI Units, (Transl. in Greek by A. Vronteli, P.Tsiakaras), Edit. Tziola (2011) 4. Y.A. Cengel, M.A. Boles, "Thermodynamics: An Engineering Approach", 7th Edition in SI Units (Transl. in Greek by P.Tsiakaras, E.Kotsialos), Edit. Tziola (2011)

Teaching and learning methods	Lectures with strong emphasis on step-by-step problem solving. Students are encouraged to solve many more problems at home, using recommended textbooks, which cover to a fully adequate degree the course content (theory, problems and data bases).
Assessment and grading methods	Final written exam in solving practically oriented problems with open books and student notes (100% of final grade).
Language of instruction	Greek
Course URL	

Materials Science

Course title	**Materials Science**
Course code	**CHM_381**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	3^{rd}
Semester	5^{th}
ECTS credits	6
Names of the lecturer	George N. Angelopoulos –Stella Kennou
Learning outcome	After completing this course a student should be able to: 1. Know the fundamental science and engineering principles relevant to materials. 2. Understand the relationship between nano/microstructure, characterization, properties and processing and design of materials. 3. Have the fundamental experimental and computational skills as engineers in materials. 4. Be able to apply general math, science and engineering skills to the solution of engineering problems. 5. Be able to apply core concepts in Materials Science to solve engineering problems. 6. Be able to select materials for design and construction. 7. Be able to analyze data. 8. Possess the skills and techniques necessary for modern materials engineering practice.
Competences/Skills	At the end of the course the student will have further developed the following skills/competences: 1. Possess knowledge of the significance of research and environmental/social issues surrounding materials 2. Have the experimental and computational skills for a professional career or graduate study in materials.

	3. Be aware of the social, safety and environmental consequences of their work, and be able to engage in public debate regarding these issues. 4. Understand the professional and ethical responsibilities of a materials' scientist and engineer.
Prerequisites	There are no prerequisites for this course. However, students should have basic knowledge of mathematics and physics.
Course contents	***Introduction*** Materials Science description. The Era of Materials. The Greatest Materials Moments. Environmental and Other Effects. Examples. ***Atomic Structure and Bonding*** Atomic bonding. Periodic table of elements. Atomic bonding and properties of Materials. Intermetallic Compounds. Examples. ***Atomic and Ionic Arrangements.*** Crystal structure. Atomic arrangements. Structure of metals. FCC, HCP, BCC structures. Structure of ceramics. Points, Directions, and Planes in the Unit Cell. Allotropic or Polymorphic Transformations. Examples. ***Imperfections in Solids*** Dislocations. Point defects. Grain boundaries. Examples. ***Atomic movement*** Diffusion. Diffusion Mechanisms. Steady-State Diffusion. Nonsteady-State Diffusion. 1^{rst} and 2^{nd} law of Fick. Examples. ***Phase (equilibrium) diagrams*** Introduction. Phases. Microstructure. Phase equilibria. Isomorphous and Eutectic binary alloys. Eutectic, eutectoid, peritictic reactions. Phase rule (Gibbs). The iron–carbon system. Examples. ***Phase Transformations*** The Kinetics of Solid-State Reactions. Benite. Martensite. Isothermal Transformation Diagrams. Continuous Cooling Transformation Diagrams. Examples. ***Electical properties - Conductors, Insulators and Semiconductors*** Electrical conductivity - Electrical constant. Piezoelectricity, Intrinsic semiconductors, p and n type semiconductors, transistors, Integrated circuits, Transistors, MEMS. Examples. ***Optical properties*** Interaction of light with solids.- Reflectivity, Polarization, Optoelectrical devices.Examples. ***Magnetical properties*** Magnetical fields, Induction, Magnetization, - Επαγωγή- Diamagnetism, Paramagnetism, Ferromagnetism, Magnetic materials and applications. Examples. ***Thermal properties***

	Metals, Ceramics and Polymers- Applications. Examples **Nanomaterials** Properties (mechanical, optical, magnetical, electronic structure). Fullerenes, Carbon nanotubes, metallic nanoparticles, nanotubes quantum dots - applications **Keywords**: Material Science, Material Engineering,
Suggested reading	1. D. Chrisoulakis, D. I. Pantelis, Science and Engineering of Metallic Materials, Edit. Papasotiriou, 2003. ISBN: 960-7510-39-9 2. W.D. Callister, Jr., Science and Engineering of Materials, Edit. Tziola, 2004. ISBN: 960-8050-90-1 3. R. Askeland, The Science and Engineering of Materials, Edit. Chapman & Hall, 1996. ISBN: 0-412-53910-1 4. M. Ashby, H. Shercliff, D. Cebon, Materials. Engineering, science, processing and design, Edit. Klidarithmos, 2011. ISBN: 978-960-461-449-3 5. G. N. Chaidemenopoulos, Physical Metallurgy, Edit. University of Thessaly, 2000. ISBN: 960-8029-05-8 6. G. K. Triantafillidis, Metallurgy. For the non-Metallurgical Engineer and Materials Technologist, Edit. Tziola, 2013. ISBN: 978-960-418-380-7
Teaching and learning methods	Lectures using electronic and conventional means. Analytic presentation of selected example and problems solutions
Assessment and grading methods	1. Set of exercises, optionally (up to 25% of the final mark) 2. Written examination (80-100% of the final mark)
Language of instruction	Greek
Course URL	http://www.chemeng.upatras.gr/en/content/courses/en/materials-science

Microbiology

Course title	**Microbiology**
Course code	**CHM_680**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	3rd
Semester	5th
ECTS credits	4
Name of lecturer	Dimitris Vayenas
Learning outcome	The students will study the structure of prokaryotic and eukaryotic microbial cell and of viruses, and comprehend the biology of microorganisms on molecular level, as well as the

	mechanisms used by the microorganisms for energy generation. Also, they will learn the biology of representative genera of bacteria and fungi and of important viruses.
Competences/Skills	The students will be able to: 1) use aseptic technique 2) isolate microorganisms from environmental samples and establish pure microbial cultures 3) examine macroscopically microbial colonies and differentiate among fungi, yeasts and bacteria. 4) estimate density of microbial populations in foods (i.e. milk) 5) examine microscopically pure microbial cultures 6) use stain procedures 7) study life cycle of fungi 8) examine sensitivity of bacteria to antibiotics
Prerequisites	Formally there are no prerequisites. However, knowledge of General Biology, Biochemistry and Molecular Biology is recommended.
Course contents	1. Evolution of the science of Microbiology 2. Organization and structure of prokaryotic and eukaryotic cell: cytoplasmic membrane and its functional role, cell wall, flagellum. Chemotaxis. The bacterial endospore. Chromosome and plasmids. Ribosomes. 3. Molecular biology of microorganisms: DNA replication, gene expression, regulation of gene expression, DNA transfer in bacteria. 4. Generation of energy in aerobic and anaerobic microorganisms, chemoautotrophy, photoautotrophy. 5. Microorganisms without a cellular structure. 6. Taxonomic hierarchies and taxonomic unit. 7. The microbial world. 7.1. Gram negative bacteria [aerobic. facultative anaerobic], Gram positive [cocci, spore forming, regular and irregular non-spore forming]. Mycobacteria. Photosynthetic. Aerobic chemolithotrophic. Actinomycetes. 7.2. Archaea (methanogens, sulfate reducers, cell wall-less, extremely halophilic, extremely thermophilic sulfur-metabolizing). 7.3. Characteristics of Fungi. Chytridiomycota, Zygomycota [*Rhizopus*, *Mucor*, Mycorrhizae], Ascomycota [*Aspergillus*, *Schizosaccharomyces* and *Penicillium*, Order Lecanorales, Order Saccharomycetales], Basidiomycota [genus *Agaricus*, White and brown rot fungi, Order Uredinales - the rust fungi, Order Ustilaginales – the smut fungi]. 7.4. Fungi-like organisms. 7.5. Viruses: Animal viruses [Adenoviruses, Retroviruses], plant viruses [tobacco mosaic virus], phages [T4, λ].

Recommended reading	1. «*Microbiology and Microbial Technology*», G. Aggelis, A. Stamoulis Publishers, Athens 2007. 2. «*Microbiology*», S. Koliais, Studio University Press, Thessaloniki 1992.
Teaching and learning methods	Lectures, Laboratory exercises
Assessment and grading methods	Written exams at the end of semester. Exams during semester.
Language of instruction	Greek
Course URL	

Materials Laboratory

Course title	**Materials Laboratory**
Course code	**CHM_481**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	3rd
Semester	5th
ECTS credits	3
Name of the lecturer	Victor Stivanakis
Learning outcome	1. At the end of this course the student should be able to understand the principles and procedures used: − Treatment and preparation of metallic specimens for optical observation. − Processes required for the hardening of metals with desirable results. − Hardness measurements of the metallic samples surfaces − Thermal analysis of metals and their alloys − Construction of phase diagrams using experimental data 2. The student should be able to: − combine the theoretical fundamentals (from the course "Materials Science I") with the results obtained during the experiments and analyses in order to program processes (thermal, mechanical, etc.) with desired results (technological properties of metals) − estimate the thermal and mechanical prehistory of the metallic samples with macroscopic observations
Competences/Skills	At the end of the course the student will have further developed the following skills/competences: − be able to use equipment's and tools for sample preparation (cutting devices, hydraulic mounting press, polishing,

	etching, laboratory muffle furnaces, temperature measurement devices) – be able to use optical devices (microscopes, stereoscopes) – cooperation among students – presentation and discussion of the results within a group
Prerequisites	There are no prerequisite courses. The students should have a basic knowledge of Material Science I.
Course contents	– Preparation of metallic specimens for metallographic observation. – Sectioning of metallographic samples by a discotom. – Hot mounting of the sample in the appropriate resin. – Stepwise polishing of mounted sample. – Chemical etching of the metallic sample. – Observation of a metallic cross-section by optical microscope. Drawing conclusions on the type and the structure of the observed sample. – Thermal analysis of metals and their alloys. – Methods for temperature measurements. – Construction of a two component phase diagram. – Hardening of plain and alloyed steels with rapid local heating and cooling device Jomini (Martensitic transition) – Influence of the hardening on the crystalline structure and the technological properties. – Hardness measurement on metal samples and construction of diagrams. – Conclusions and comparison of the results among the plain steel and their alloys. – Correlation of the obtained measurement results with the CCT (continuous cooling transformation) diagrams (cooling rate, hardness).
Suggested reading	– Instructor notes – "Μεταλλογνωσία" (Κράματα, Μέταλλα, Βιομηχανικά Κράματα), Κ. Κονοφάγος – "Εισαγωγή στην Επιστήμη των Υλικών- Μεταλλογνωσία", Π. Νικολόπουλος. – "Materials Science and Engineering: An Introduction" William D. Callister.
Teaching and learning methods	Lectures using PowerPoint presentations Training in groups Presentations of the conclusions
Assessment and grading methods	1. Oral presentation by each group of students (70% of the final mark). 2. Tests and participation in the laboratory (30% of the final mark).
Language of instruction	Greek

Course URL	

3rd Year – 6th Semester

Heat Transfer

Course title	**Heat Transfer**
Course code	**CHM_650**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	3rd
Semester	6th
ECTS credits	6
Name of the lecturer	Panagiotis Vafeas
Learning outcome	In the end of the course, the student should: 1. Comprehend the basic principles and modes of heat transfer and the physical significance and importance of the relevant dimensionless numbers for solving heat transfer problems. 2. Be able to develop microscopic and macroscopic heat transfer balances in steady and transient state.
Competences/Skills	The student will have developed the following skills: 1. He/she will be able to simplify complex heat transfer phenomena to simpler ones, to develop and simplify heat flow balances, to determine suitable auxiliary conditions and solve the final equations. 2. He/she will understand the difference between heat conduction, convection (forced & free) and radiation. The required in each case assumptions and the procedure to solve the corresponding problems.
Prerequisites	Prerequisite courses have not been set. The students however, must have good knowledge of differential and integral calculus of methods to solve differential equations of Fluid Mechanics and elements of Thermodynamics.
Course contents	INTRODUCTION TO HEAT TRANSFER. Modes of heat transfer – examples. Fourier law for heat conduction, Newton correlation in heat convection. General differential equation for heat transfer. Boundary and initial conditions in heat transfer problems. The significance of the Biot number. STEADY 1D CONDUCTION. Heat generation in the bulk and on material interfaces. Addition of heat resistances in various geometries. Fin approximation. STEADY CONDUCTION IN 2D. Exact solutions via separation of variables. Shape factor. Solution using charts and polynomial approximations.

	TRANSIENT CONDUCTION IN 1D. The similarity and the Laplace transformation. Solution using separation of variables. Approximate solutions. TRANSIENT MULTIDIMENSIONAL CONDUCTION. Approximate analysis and solution. Separation of variables. INTRODUCTION TO HEAT CONVECTION. Forced and free convection. Dimensionless analysis. Examples admitting simple analytical solution. Approximate correlations in heat convection. Analogies in heat, mass and momentum transfer and similarity. The Nusselt, Graetz, Prandtl and Peclet numbers FORCED CONVECTION INSIDE DUCTS AND AROUND BODIES. Convection over a surface, the boundary layer in heat transfer. Entrance length in ducts. Developing and developed flow with respect to flow and heat characteristics. Using polynomials to obtain approximate solutions and correlations/diagrams to solve problems. Convection in turbulent flow. FREE CONVECTION. Free convection around bodies. Coupled free and forced convection. The Grashof and Rayleigh numbers. HEAT EXCHANGERS. Types of heat exchangers and their use. Total heat transfer coefficient. HEAT RADIATION. Radiation laws by Planck & Stefan-Boltzmann. Radiation & absorption. The black & brown body. Radiation between brown bodies.
Suggested reading	**Course Textbook** Μεταφορά θερμότητας και Μάζας, Ασημακόπουλος, Λυγερού, Αραμπατζής. Εκδ. Παπασωτηρίου, 2012 **Books for additional studying** 1. Heat Transfer, 7th Ed., Holman, 1990, McGraw Hill 2. Transport Phenomena, Revised 2nd Ed., Bird, Stewart, Lightfoot, 2007, Wiley 3. Fundamentals of Momentum, Heat & Mass Transfer, Welty, Wicks, Wilson, 1984, Wiley. 4. Fundamental Principles of Heat Transfer, Whitaker S., 1977, Krieger 5. Αρχές μεταφοράς θερμότητας & μάζας, Κακάτσιος, Εκδ. Συμεών, 2006. 6. Fundamentals of Transport Phenomena, Fahien R.W., 1983, McGraw Hill.
Teaching and learning methods	Besides the lectures, exercises are given to better understand the course content. Additionally review exercises are given similar to those that have been given in past exams. The students are strongly encouraged to solve them before their presentation in special review lectures to maximize the benefit to them and to better prepare for the final exam.
Assessment and grading methods	The course grade is determined by the final exam.

Language of instruction	Greek
Course URL	

Mass Transfer

Course title	**Mass Transfer**
Course code	**CHM_755**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	3rd
Semester	6th
ECTS credits	4
Name of the lecturer	Dionissios Mantzavinos
Learning outcome	The aim of this course is to educate students on mass transfer issues, where primarily the transfer of a chemical species or of a substance is transferred from areas of high concentration to areas of low concentration, with the driving force being the concentration difference. Students learn to make mass balances, determine the differential equation governing the problem, choose the correct boundary (or limit and initial) conditions and learn to calculate the distribution of concentration along the motion 'under review' component and mass transfer rates. At the end of the course (2-3 weeks), students acquire knowledge of the mass transfer in porous materials and solve similar problems.
Competences/Skills	At the end of this course the student will have developed the following skills: 1. Solving molecular diffusion problems, calculate diffusion coefficients in gaseous and liquid mixtures Solve diffusion problems in various applications-linking of these problems with applications to problems of unit operations such as evaporation, distillation, absorption, chemical processes, etc. 2. Solving problems in porous media
Prerequisites	To attend the course the students are encouraged to refresh their basic knowledge on transport phenomena (Fluid Flow and Heat Transfer). We will also use some knowledge from the course 'Technical Thermodynamics and Balances'.
Course contents	Individual course includes the following modules: Introduction: Definition of concentrations, Velocities and special flux rates. Law of Fick. Phenomenological theory of molecular diffusion. Diffusion coefficient: gas, liquid and solid media. Differential equations of mass transfer (balances). Usual

	initial and boundary conditions. Molecular diffusion: concentration distribution in solids and fluids resting. Steady state and transient molecular diffusion. Exact analytical solutions of standard problems, steady state and transient molecular diffusion. DIFFUSION AND REACTION: Diffusion with homogeneous chemical reaction. Diffusion with heterogeneous reaction. Relative influence of the mass transfer rate and reaction. Diffusion porous materials: Molecular diffusion in porous materials. Knudsen diffusion, Surface diffusion DIFFUSION AND REACTION IN CATALYTIC GRAIN. SPECIAL TOPICS IN MASS TRANSFER: Theory of diffusion in gases at low pressure, Knudsen diffusion, diffusion in binary mixtures, diffusion in solid solids, diffusion in porous bodies and diffusion in multicomponent mixtures. CONVECTIVE MASS TRANSFER: Dimensional analysis and similarity. Convection at low and high Reynolds and Peclet numbers. Mass transfer coefficient. Proportions of mass transfer and heat linear momentum. Proportions of Colburn and von Karman. MASS TRANSFER THROUGH INTERFACE: partition coefficient. Mass transfer coefficient. Marangoni type phenomena. MASS TRANSFER with natural convection: Effect of density gradient in the fluid flow and concentration distribution. **Keywords:** Diffusion, diffusion coefficients, molecular diffusion, mass diffusion with convection, diffusion in porous media, Law of Fick.
Suggested reading	1. AC Payatakes, Lecture Notes A. Mass Transfer, University of Patras B. Special Topics in Mass Transfer (supplement), University of Patras 2. Ligerou Vasiliki, Asimakopoulos Dionisis, Arabatzis George, "Mass Transfer", A.Papasotiriou & Co Editions, Athens, 2005 3. Brodkey Robert S., Hershey Harry C., "Transport Phenomena", A.Tziola & Sons Editions, Thessaloniki, 2011
Teaching and learning methods	Oral presentations, tutorials, homework
Assessment and grading methods	Due to the limited time (only three hours/week) there is no time for intermediate examinations (progress). However during the course students are asked to solve exercises (homework) similar to those taught in the course of the day and to deliver them without necessarily granting extra bonus.
Language of instruction	Greek
Course URL	

Instrumental Chemical Analysis

Course title	**Instrumental Chemical Analysis**
Course code	**CHM_515**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	3rd
Semester	6th
ECTS credits	4
Name of the lecturer	Alexandros Katsaounis – Symeon Bebelis
Learning outcome	At the end of this course the student should be aware of the: 1. Fundamentals, instrumentation and applications of chromatography in chemical analysis. 2. Fundamentals, instrumentation and applications of spectroscopy in chemical analysis. 3. Fundamentals, instrumentation and applications of Electroanalytic chemistry.
Competences/Skills	At the end of the course the student will have further developed the following skills/competences: 1. To be familiar with different types of analytic methods, analytical instrumentation, and calibration methodology. 2. To be able to choose an instrumental method of analysis depending on the application and analysis needs to be faced.
Prerequisites	There are no prerequisite courses. It is, however, recommended that students should have a basic knowledge of unit operations and chemical reaction engineering.
Course contents	Extraction. Chromatographic methods of analysis. Theory of chromatography. Liquid chromatography, gel chromatography. Gas chromatography. Spectroscopy in chemical analysis. Matter-radiation interaction. Quantitative analysis with absorption chromatography. Instrumentation. Infra-red spectrometry. UV-VIS spectroscopy. Flame photometry. Atomic absorption spectroscopy. X-ray spectrometry. Electroanalytical methods: Basic principles of electrochemistry (Electrodes and electrochemical cells, Electrochemical thermodynamics and kinetics), Electrogravimetric analysis, Coulometry, Voltammetry, Potentiometry, Conductometry.
Suggested reading	1.΄΄Principles of Instrumental Analysis΄΄ Skoog, Holler, Nieman (transl. in Greek), Kostarakis Editions (ISBN 978-960-87655-7-3) 2.΄΄Modern techniques in chemical analysis΄΄ Pecsok, Shields, Cairns, McWilliam, (transl. in Greek), Pnevmatikos Ed. (ISBN: 960-7258-27-4)

	3. ´´Handbook of Instrumental Techniques for Analytical Chemistry´´ Frank A. Settle (editor), (ISBN: 0131773380)
Teaching and learning methods	Lectures using power-point presentations and problem solving based on the syllabus of the course
Assessment and grading methods	1. Problem solving and applications of instrumental chemical analysis by the students every week (2 units bonus to the final mark if it is > 5) 2. Final written exams
Language of instruction	Greek
Course URL	https://eclass.upatras.gr//courses/CMNG2142/

Chemical Reaction Engineering I

Course title	**Chemical Reaction Engineering I**
Course code	**CHM_741**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	3rd
Semester	6th
ECTS credits	6
Name of the lecturer	Constantinos Vayenas
Learning outcome	At the end of the Course the student should be able to: 1. Compute adiabatic temperatures and chemical equilibrium compositions. 2. Understand the principles of chemical kinetics. 3. Describe in detail the operation and design of the main types of ideal chemical reactors. 4. Describe the main types of non-ideal chemical reactors.
Competences/Skills	- Ability to use the basic principles of chemical Thermodynamics for computing equilibrium compositions. - Ability to analyze and solve problems on chemical kinetics and on homogeneous ideal and non-ideal chemical reactors.
Prerequisites	- Introduction to Chemical Engineering - Chemical Thermodynamics I & II
Course contents	Adiabatic temperature, chemical equilibrium, fugacity, activity, chemical potential, principles of chemical kinetics, design equations of ideal chemical reactors, batch, CSTR, PFR. Non-ideal reactor models.
Suggested reading	- H. Scott Fogler, "Elements of Chemical Reaction Engineering", Prentice-Hall International, Inc. (1986).

	- C.G. Vayenas, "Analysis and Design of Chemical Reactors", Patras University Press (1986), in Greek - X.E. Verykios, "Chemical Reaction Kinetics and Design of Chemical Reactors", University of Patras Press, Patras (1992), in Greek
Teaching and learning methods	Class lectures, weekly homeworks
Assessment and grading methods	- In class and take-home exercises (20%) - Progress exam (40%) - Final exam (40%)
Language of instruction	Greek or English
Course URL	

Process Dynamics & Control

Course title	**Process Dynamics & Control**
Course code	**CHM_840**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	3rd
Semester	6th
ECTS credits	7
Name of the lecturer	I. Kookos – S. Pavlou
Learning outcome	After completing this course a student should be able to: 1. Have a good understanding of how to calculate and analyze dynamic behavior of physical systems, including fundamental notions of dynamics like stability and transfer function. 2. Use and simplify block diagrams. 3. Construct and interpret Bode diagrams and root locus diagrams. 4. Understand the significance of controller actions (proportional, integral, derivative). 5. Apply methods of optimal tuning of PID controllers.
Competences/Skills	At the end of the course the student will have further developed the following skills/competences: 1. Ability to relate the mathematical description with the characteristics of dynamic response of physical systems. 2. Ability to calculate the dynamic response of processes in open loop and in closed loop. 3. Ability to use MATLAB in dynamics and control calculations.

Prerequisites	There are no prerequisite courses. Students should have some basic knowledge of differential equations and mass and energy balances.
Course contents	DYNAMIC RESPONSE OF PHYSICAL SYSTEMS. First-order systems. Connections of first order systems. Second-order systems. Time delay systems. MATHEMATICAL METHODS FOR THE ANALYSIS OF DYNAMIC SYSTEMS. Solution of linear vector differential equations with the exponential matrix method. Asymptotic stability of linear systems. Solution of linear differential equations using Laplace transforms. Transfer function. Poles and zeros. Input/output stability. Frequency response calculation. Bode diagrams. Linearization of nonlinear dynamic systems. Local asymptotic stability – Lyapunov's first method FEEDBACK CONTROL SYSTEMS. Measuring devices. Final Control Elements. Controllers with proportional, integral and/or derivative actions (PID). Block diagram representation of a control system. Block diagram simplification. Closed loop transfer functions. State-space description of a closed loop system. ANALYSIS AND DESIGN OF CONTROL SYSTEMS. Steady state error - significance of integral action. Sensitivity function. Closed loop stability analysis. Routh stability criterion. Bode stability criterion. Gain and phase margins. Root locus diagram. Calculation of performance criteria for control systems and optimization. **Keywords - basic terms**: dynamic system; input; output; dynamic response; transfer function; stability; feedback; controller; block diagram; closed loop system.
Suggested reading	1. N. Krikelis, "Introduction to Automatic Control", Symmetria, 2000 (in Greek). 2. R. C. Dorf and R. H. Bishop, "Modern Control Systems", Translation in Greek, Tziola, 2003. 3. P. Daoutidis, S. Mastrogeorgopoulos and S. Papadopoulou, "Process Control", Tziola, 2012 (in Greek).
Teaching and learning methods	Lectures, discussion sessions, laboratory experiments.
Assessment and grading methods	1. Written lab reports (15% of the final mark). 2. Written examination (85% of the final mark)
Language of instruction	Greek
Course URL	

Polymers Laboratory

Course title	**Polymers Laboratory**
Course code	**CHM_671**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	3rd
Semester	6th
ECTS credits	3
Name of the lecturer	C. Tsitsilianis
Learning outcome	At the end of this laboratory course the student should be able to : 1. Organize and perform experiments using instrumental analytical techniques for the characterization of polymers and determination of their properties. 2. Be acquainted with the basic knowledge of these techniques and process the data of the experiments. 3. To evaluate the result and understand the polymers' properties from both laboratory experiments and "Polymer Science" course.
Competences/Skills	At the end of this laboratory course the student will have further developed the following skills/competences : 1. Ability to choose the appropriate technique for the determination of the molecular properties of polymers. 2. Ability to determine the thermal, rheological and mechanical properties of polymers. 3. Ability to present and propose characterization techniques and study polymers' properties in his future professional development.
Prerequisites	There no prerequisite courses. It is however, recommended that students should have at least basic knowledge of Polymer Science and Instrumental Analysis.
Course contents	1. Viscometry Determination of intrinsic viscosity, average molecular weight M_v and molecular size of macromolecules by using Ubbelohde viscometers. 2. Gel permeation chromatography (GPC) Determination of average molecular weights and molecular weight distribution of polymers. 3. Infrared spectroscopy (FTIR) Application of FTIR for the identification of polymers and determination of copolymer composition. 4. Ultra violet spectroscopy (UV)

	Application of UV spectroscopy for the study of polymer solubility. Determination of Θ temperature and the lower critical solution temperature (LCST). 5. Differential scanning calorimetry (DSC) Determination of glass transition temperature, degree of crystallization and melting temperature of polymeric samples. 6. Tensile Testing Stress-strain curves of various polymeric samples and determination of mechanical ultimate properties. 7. Polymer Rheology Study of the rheological behavior of concentrated aqueous polymer solutions by using Couete viscometer, effect of M_w and temperature.
Suggested reading	1. "Polymer Laboratory" University Notes, K. Tsitsilianis, Our. Kouli, Patras, February 2013 (in Greek). 2. Experiments in Polymer Science, E.A. Collins, J. Bares, F.W. Billmeyer, Jr. Wiley, New York, 1973.
Teaching and learning methods	Laboratory practice: the students work in teams of four.
Assessment and grading methods	1. Multiple choice test, before practice (25%) 2. Report with the results (25%) 3. Final writing examination (50%) Minimum average passing grade : 5
Language of instruction	Greek. Instruction may be given in English in case foreign students attended the laboratory course.
Course URL	

4th Year - 7th Semester

Unit Operations I

Course title	**Unit Operations I**
Course code	**CHM_655**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	4th
Semester	7th
ECTS credits	6
Name of the lecturer	Christakis A. Paraskeva
Learning outcome	The course aims to familiarize students with the basic methods of separating various mixtures (gas-gas, gas-liquid, gas-solid, liquid-liquid, liquid-solid, solid-solid) and learn methods of designing basic units of separation processes and ways calculations of mass and energy balances (emphasis in fractional distillation, absorption, and solid fluidized beds, filtration membranes (Ultrafiltration, nanofiltration, reverse osmosis). Alongside the lesson is taught in the software HYSYS ASPEN Technology, for the design of integrated separation processes and the numerical solution of mass and energy balances.
Competences/Skills	At the end of this course the student will have further developed the following skills: 1. Ability to design simple distillation process, absorption columns and fixed and fluidized beds, etc by hand and apply the relevant mass and energy balances 2. Ability to use software packages such as HYSYS, ASPEN PLUS to simulate complex processes of distillation and absorption etc, and to design complex chemical engineering processes.
Prerequisites	To attend the course the student is encouraged to refresh basic thermodynamics and physical chemistry knowledge especially for equilibrium vapor-liquid and liquid-liquid systems. We will also use knowledge from the course 'Technical Thermodynamics and Balances'.
Course contents	Individual course includes the following modules: *Distillation* - Distillation of binary mixtures: Equilibrium distillation, differential distillation, fractional distillation, Method McCabe-Thiele, Method Ponchon-Savarit, Performance Murphree. - Fractional distillation of multicomponent mixtures: Method wholesale analysis method accurate analysis. *Absorption:* Design equations and analysis, Absorption multistage countercurrent, Processes continuous contact Absorption complex mixtures.

	Adsorption: Balance and isotherms (Langmuir, BET, etc.), dynamics and principles of adsorption curves crossing, Design of adsorption processes. *Evaporation, drying and extraction.* *Fixed and Fluidized Beds*: Conditions for fluidization. Gas-solid systems. *Process simulation software packages in Chemical Engineering.* **Keywords:** Distillation, Absorption, fluidized beds, filtration membranes, design processes
Suggested reading	John Yentekakis, "Unit Operations", KLEIDARITHMOS Ltd. Editions, Athens, 2010 McCabe Warren, Smith Julian C., Harriott Peter "Basic Chemical Processes Engineering' A. Tziola & Sons, Publishing, Thessaloniki, 2002 Assael Markos I., Mangiliotou Mariam C., "Unit Operations", A. Tziola & Sons, Publishing, Thessaloniki, 2009 D. Marinos-Kouris, E. Parliaros-Tsamis 'Exercises on Unit Operations', Papasotiriou Publishing, 1994
Teaching and learning methods	Oral presentations, three series of exercises two intermediate tests, practice in using HYSYS software and delivery of technical reports.
Assessment and grading methods	Students can optionally participate in the following rating system: (Two intermediate tests + 3 series of exercises) x 0.8 + (laboratory grade) x 0.2 = Final Grade or (Final exam) x 0.8 + (laboratory grade) x 0.2 = Final Grade Students wishing to participate in both evaluation methods can do as final grade is considered the greatest degree resulting from both ways of examination.
Language of instruction	Greek
Course URL	

Biochemical Process Engineering

Course title	**Biochemical Process Engineering**
Course code	**CHM_742**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	4th
Semester	7th
ECTS credits	6
Name of the lecturer	Dionissios Mantzavinos

Learning outcome	The course offers an introduction to biochemical engineering fundamentals, alongside the knowledge needed for the design of processes that are based upon the use of biological cells and/or enzymes for the production of useful end-products and/or waste treatment.
Competences/Skills	At the end of this course the student will have developed skills regarding: 1. Mass balances, stoichiometry and kinetics of biochemical reactions. 2. Design, simulation and optimization of bioreactors. 3. Separations in biochemical processes.
Prerequisites	Students are encouraged to refresh basic knowledge from their XM680 course in Microbiology.
Course contents	Basics of microbiology, biochemistry and genetics. Biochemical reaction stoichiometry and mass balances. Enzyme kinetics. Kinetics of microbial growth, substrate utilization and metabolic product generation. Bioreactor types (batch, fed-batch, CSTR). Bioreactor design and optimization. Bioseparations.
Suggested reading	1) Biochemical Engineering Fundamentals, Bailey & Ollis, 2nd edition, McGraw-Hill 2) Bioprocess Engineering, Shuler & Kargi, Prentice-Hall 3) Introduction to Biochemical Engineering, Lyberatos & Pavlou, Tziolas Publications (in Greek)
Teaching and learning methods	Lectures, tutorials.
Assessment and grading methods	Final exam.
Language of instruction	Greek
Course URL	

Plant Design and Economics

Course title	**Plant Design and Economics**
Course code	**CHM_941**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	4th
Semester	7th
ECTS credits	6
Name of the lecturer	Ioannis K. Kookos

Learning outcome	After completing this course a student should be able to: 1. generate and solve systematically energy and material balances, 2. build Process Flow Diagrams using systematic procedures, 3. complete the preliminary sizing using minimum information, 4. undertake preliminary economic analysis and evaluation.
Competences/Skills	At the end of the course the student will have further developed the following skills/competences: 1. ability to understand the structure and analyze Process Flow Diagrams 2. ability to use process simulators such as HYSYS, UNISIM and ASPEN PLUS in modeling chemical/biochemical processes 3. ability to judge the viability of investment in new products or processes
Prerequisites	There are no prerequisites for this course. However, students should have basic knowledge of mass and energy balances and unit operations.
Course contents	Systematic development and solution of energy and material balances. Degree of freedom analysis and solution of non-linear equations. Recycle streams and implications to the solution of the material and energy balances for complete plants. Thermodynamic data and collection of. Thermodynamic models of ideal and non-ideal mixtures. Estimation of thermo-physical properties using group contribution methods – method of Joback and method of Gani. Thermodynamic model of Raoult, model of activity coefficients and cubic (and other) equations of state. Implementation of thermodynamic models into computer software and selection of appropriate thermodynamic model. Process flow diagrams (PFDs) (PFDs) and Process and instrumentation diagrams (P&IDs). Preliminary design and costing of classical unit operations. Preliminary sizing of distillation columns, extraction columns, absorption columns, heat exchangers, pumps and compressors. Estimation of f.o.b. equipment cost. Estimation of installed equipment cost, cost of direct labor, cost of utilities. Depreciation and cost of manufacture. Evaluation of investment plans. Indices of financial performance. Net present value, return of investment and pay-back time. Application to production units: production of styrene, bio-diesel, bio-ethanol. **Keywords**: Material and energy balances; Design data; Process Flow diagrams; Preliminary design.

Suggested reading	I.K. Kookos, Introduction to the Analysis of Chemical Processes, Tziola Publishing, 2009. ISBN: 978-960-418-267-1 (In Greek) I.K. Kookos, Introduction to Plant Design, Tziola Publishing, 2007. ISBN: 978-960-418-173-5 (In Greek) Peters, Timmerhaus & West, Plant Design and Economics, Tziola Publishing, ISBN: 960-418-058-4, Translation in Greek
Teaching and learning methods	Lectures, training in using computer software and supervised completion of a design project and technical writing. Problem based learning is introduced to the students.
Assessment and grading methods	Personal design project (25% of the final mark) that includes technical writing and oral examination/presentation. Written examination (75% of the final mark)
Language of instruction	Greek
Course URL	

Chemical Engineering Processes Laboratory I

Course title	**Chemical Engineering Processes Laboratory I**
Course code	**CHM_755**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	4^{th}
Semester	7^{th}
ECTS credits	3
Name of the lecturers	Ch. A. Paraskeva D. Spartinos
Learning outcome	Students are trained in basic chemical engineering processes, learn to operate experimental laboratory or semi-pilot devices, present their results in original technical reports and process of measurements exploiting the knowledge gained in their respective theoretical courses.
Competences/Skills	At the end of this course the student will have developed the following skills: 1. Familiarity with the operation of laboratory and semi-pilot devices 2. Get experimental results and make the appropriate calculations, Evaluation of the results 3. Apply knowledge of subjects such Fluid Flow, Mass Transfer, Physical Processes, Chemical Process,

	Instrumental Chemical Analysis in calculations required by each laboratory exercise.
Prerequisites	To attend the course, students are encouraged to refresh their basic knowledge of the course Fluid Flow, Unit Operations, Mass Transfer, Chemical Process, and Chemical Reactor Design and Mass and Energy Balances.
Course contents	The Chemical Engineering Processes Laboratory I comprises seven exercises, four refer to Unit Operations (Instructor C. Paraskeva) and three to Chemical Processes (Instructor D. Spartinos). The exercises are performed by groups of 3-4 students. The exercises of Unit Operations are: • Gas Absorption • Solid and fluidized bed • Drag coefficient and viscosity • Diffusion of liquids and gases The exercises of Chemical Process are: • Study of Chemical Reaction Kinetics in Gas Chromatography. • Residence time distribution in a stirred reactor. • Catalytic Oxidation of Ethylene. **Keywords:** Unit Operations, Chemical Processes, absorption columns and towers, viscosity, chemical reaction kinetics, catalytic oxidation, residence time distribution.
Suggested reading	C. A. Paraskeva, D. Spartinos, 'Notes on Chemical Engineering Processes' University of Patras, 2012, Patras
Teaching and learning methods	Oral presentations of laboratory exercises in the beginning of the semester by the instructors, analytical exercise presentation and explanation of the calculations to be made in each exercise, by the head of each exercise at the laboratory
Assessment and grading methods	The evaluation of the exercises of **Unit Operations** is as follows: 1. Oral examination at the beginning of exercise to see the preparation that made by the student (20%), 2. Written examination, after running all 4 exercises (theory and simple exercises) (40%), 3. Marking of the final report (40%). The evaluation of the exercises of **Chemical Processes** is as follows: 1. Oral examination at the start of exercise to see the preparation that made the student and a written examination at the end of each exercise (50%), 2. Marking of the final report (50%) In the end, the average of the seven exercises is summed and averaged out the course.

Language of instruction	Greek
Course URL	

Chemical Reaction Engineering II

Course title	**Chemical Reaction Engineering II**
Course code	**CHM_841**
Type of course	Compulsory
Level of course	Undergaduate
Year of study	4th
Semester	7th
ECTS credits	6
Name of the lecturer	Xenophon Verykios
Learning outcome	At the end of the course the student should be able to: 1. Have a good understanding of basic issues of catalysis and solid catalysts. 2. Have a good understanding of the concept of the intrinsic rate of catalytic reactions and know the experimental procedure for its determination. 3. Understand the concept of the global (overall) rate. 4. Have the ability to estimate the influence of external and internal mass and heat transfer on the global rate. 5. Be familiar with the different models of simulation of catalytic reactors and their basic assumptions.
Competences/Skills	1. At the end of the course the student will have further developed the following skills/competences: 2. Ability to understand the basic principles and applications of heterogeneous catalysis and the structure of solid catalysts. 3. Ability to develop the intrinsic rate of catalytic reactions through their mechanism and to test it with experimental data. 4. Ability to incorporate phenomena of external and/or internal mass and heat transfer to the intrinsic rate and develop the global rate of catalytic reactions.
Prerequisites	Chemical Reaction Engineering I
Course contents	1. Qualitative description of various types of heterogeneous reactors. 2. The catalytic action, catalytic reactions, preparation and characterization of catalysts. 3. Mechanisms of catalytic reactions and development of the intrinsic rate. 4. Mass and heat transport phenomena in various reactor types.

	5. Internal mass and heat transport phenomena. Effectiveness factor. 6. Catalytic reactor models and basic principleas of their simulation.
Suggested reading	1. X. E. Verykios, " Heterogeneous Catalytic Reactions and Reactors", Kostarakis Publications, Athens 2004 (in Greek) 2. Vayenas, "Analysis and Design of Chemical Reactors", University of Patras Press, 1998 (in Greek) 3. M. Smith, "Chemical Engineering Kinetics", McGraw-Hill, New York 1981. 4. G. F. Froment and K. B. Bischoff, "Chemical Reactor Analysis and Design", John Wiley, New York 1979.
Teaching and learning methods	Lectures and problem solving sessions.
Assessment and grading methods	Problem solving through the entire semester (mandatory) One or two quizzes during the term. Final written exam at the end of the term
Language of instruction	Greek
Course URL	

Economics of Innovation and Technology

Course title	**CHM_794**
Course code	**Economics of Innovation and Technology**
Type of course	Elective
Level of course	Undergraduate
Year of study	4th
Semester	7th
ECTS credits	3
Name of lecturer	K. Tsekouras (Department of Economics)
Learning outcome	In the course's context, the basic theoretical argumentations of the founders of the discipline are presented. More specifically, the models developed by J. Schumpeter, K. Arrow, R. Nelson και S. Winter, concerning both the incentives for innovation and the effects arising from the embodiment of new technologies in economic and business procedures are analytically discussed. Regarding the effects of innovation the focus is on parameters as development and growth, productivity, social welfare, market structure and international trade flows. Moreover the aspects of innovation which are connected to diffusion and globalization are discussed.
Competences	1. Understanding fundamental economic mechanisms

	2. Knowledge of the economics of production and costs 3. Knowledge of the theory of technological progress 4. Knowledge of incentives for innovation and the resulting outcomes 5. Knowledge of the relationship innovation and entrepreneurship 6. Understanding the appropriability conditions and business initiatives 7. Understanding the role of globalization in innovation process 8. Knowledge of innovation – productivity improvement relationship
Prerequisites	Basic Economic Principles with emphasis on microeconomics. For students from engineering disciplines there is available reading material
Course contents	i. Basic Economic Principles with emphasis on microeconomics ii. Introduction to Innovation iii. Innovation and economics iv. Models of Innovation and R&D. v. Models of innovation diffusion vi. The effects of innovation on market structure, firm growth and productivity vii. Innovation and Globalization viii. Empirical Research results innovation
Recommended reading	**Vernardakis, N.** (2006). *Economics of Technology*. Vol. A. TYPOTHITO editions. Athens (in Greek). **Giannitsis, T.** (ed). (1991). *Economic Theory and Technology*. Athens (in Greek). **Additional Readings:** *In Greek* **Sefertzi, E.** (1998). *Innovation*. Gutenberg, Athens. **White, M.A., Bruton, G.D.** (2010). *Strategic Management of Technology and Innovation*. Kritiki Publishing. Athens. *In English* **Hall, B. and N. Rosenberg.** (eds) (2010). *Economics of Innovation* (vol. 1 and 2). North Holland, Amsterdam. **Swan, P.G.M.** (2009). *The Economics of Innovation*. Edwar Elgar Publishing, Cheltenham UK. **Encaoua, D., B. Hall, F. Laisney and J. Mairesse** (eds) (2010). *The Economics and Econometrics of Innovation*. Kluwer Academic Publishers. London. **Additional material** **Tsekouras K.** Lectures Handouts . Accessible at: (http://eclass.upatras.gr/courses/ECON1220/)
Teaching and	Lectures using slides

learning methods	
Assessment and grading methods	One (1) final exam in which your critical thinking is crucial and not your ability in memorizing.
Language of instruction	Greek
Course URL	http://eclass.upatras.gr/courses/ECON1220/

Basic Principles of Law

Course title	**Basic Principles of Law**
Course code	**CHM_792**
Type of course	Elective
Level of course	Undergraduate
Year of study	4th
Semester	7th
ECTS credits	3
Name of lecturer	G. Argyros (Department of Economics)
Learning outcome	Understanding and grasping the notions of civil law which are central to all aspects of business. These are: - rights and persons - juridical acts and contracts - torts and contractual liability - obligations - property rights
Competences/Skills	At the end of the course the student will have further developed the following skills/competencies: 1. Ability to recognize the categories of legal persons, to understand the forming of a legal entity and its function 2. Ability to understand the conclusion of a contract and its resulting obligations.
Prerequisites	There are no prerequisites for this course
Course contents	Introduction to Law. National & Legal Persons. The Right. Juridical Acts. Concept and Types of Obligations. Civil Liability. Contractual and Extra-Contractual Obligations. Normal and Anomalous Development of the Obligation. Transfer and Extinction of Obligation. Sale. Property Rights.
Suggested reading	1. "Basic Principles of Civil Law", P. Agallopoulou, Sakkoulas, Thessaloniki, 2012. 2. "Civil Law",Triantas, Nomiki Vivliothiki, Athens , 2013. 3. "Law of Obligations- General Part", Ast.Georgiadis, Sakkoulas, Thessaloniki
Teaching and learning methods	Lectures

Assessment and grading methods	Written examination
Language of instruction	Greek
Course ULR	https://eclass.upatras.gr/courses/ECON

Environmental and Natural Resource Economics for Non-Economists

Course title	**Environmental and Natural Resource Economics for Non-Economists**
Course code	**CHM_93**
Type of course	Elective
Level of course	Undergraduate
Year of study	4th
Semester	7th
ECTS credits	3
Name of lecturer	Dimitris Skuras (Department of Economics)
Learning outcome	The purpose of this course is to familiarize students of positive sciences and engineering with issues in natural resource and environmental economics as well as environmental policy. Students will be introduced to the basic economic tools for analyzing and managing natural resources from a policy perspective. They will eventually get familiar with concepts such as environmental tax and subsidy, environmental permits, etc.
Competences/Skills	At the end of this course the student is expected to develop the following competences: 1. Interest in environmental economics and policy through a basic understanding of the central issues 2. Ability to understand and grasp basic methodological issues in environmental economics and policy 3. Ability to communicate and operate in inter-disciplinary scientific teams working on environmental issues
Prerequisites	None
Course contents	Economics and the environment: A review. Basic analytical tools. The economic meaning of sustainability. Property rights and external economies. Scarcity of resources, endangered resources. Methods of environmental valuation (cost-benefit, travel cost, contingent valuation, hedonic valuation). The economics of exhaustible resources. The economics of recycling. Biological resources. An introduction to fisheries and forest economics. An introduction to environmental economics

	– basic analytical tools. Economic tools for environmental policy, taxes, standards, penalties, tradetable permits
Suggested reading	Tietenberg, T. (latest available edition). Environmental and Natural Resource Economics. Harper Collins College Publishers.
Teaching and learning methods	Lectures using slides (MS PowerPoint) combined with standard class teaching. Pure problem solving approach.
Assessment and grading methods	Final written exam
Language of instruction	Greek
Course URL	http://eclass.upatras.gr/courses/ECON1210/

4th Year – 8th Semester

Plant Design and Economics Laboratory

Course title	**Plant Design and Economics Laboratory**
Course code	**CHM_1041**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	4th
Semester	8th
ECTS credits	10
Name of the lecturer	Ioannis K. Kookos – Dimitris Vayenas
Learning outcome	After completing this course a student should be able to: 1. undertake preliminary techno-economic study of process relative to chemical engineering, 2. undertake preliminary techno-economic study for new processes or products, 3. completion of technical report.
Competences/Skills	At the end of the course the student will have further developed the following skills/competences: 1. ability to understand the structure and analyze Process Flow Diagrams 2. ability to use process simulators such as HYSYS, UNISIM and ASPEN PLUS in modeling chemical processes 3. ability to judge the potential viability of investment plans.
Prerequisites	The students should have completed successfully the course Plant Design and Economics.

Course contents	Synthesis of heat exchanger networks. Pinch point and its importance in synthesizing optimal heat exchanger networks. Minimum number of units and minimum consumption of utilities. Rules for synthesizing heat exchanger networks. Applications. Use of process simulators to extract the data necessary for undertaking a heat exchanger synthesis project. Numerical examples and applications. Applications of mathematical programming in process synthesis and design. Basic principles and definitions. Basic types of optimization problems and conditions of optimality. Non-linear programming and sequential quadratic programming. Optimization software. (MATLAB και GAMS). Approximate optimization in commercial simulation software. Response surface methodology: advantages and disadvantages. Sensitivity analysis and its implementation in commercial software such as UNISIM/HYSYS. Structure and functionality of commercial software. Recycle streams and their implementation in commercial software (such as UNISIM, HYSYS, ASPEN). Design project. Technical writing. Executive summary, main body and technical appendix. Recent design projects: DME production, Bio-diesel production, Bio-ethanol production from food industry waste streams. **Keywords**: Heat exchanger network synthesis, Optimization; Commercial simulators; Design project.
Suggested reading	K. Kookos, Introduction to the Analysis of Chemical Processes, TziolaI Publishing, 2009. ISBN: 978-960-418-267-1 (In Greek) I.K. Kookos, Introduction to Plant Design, Tziola Publishing, 2007. ISBN: 978-960-418-173-5 (In Greek) Peters, Timmerhaus & West, Plant Design and Economics, Tziola Publishing, ISBN: 960-418-058-4, Translation in Greek
Teaching and learning methods	Lectures, training in using computer software and supervised completion of a design project and technical writing.
Assessment and grading methods	Design project (50% of the final mark). The completion of the project incorporates elements of problem based learning. The supervision/assessment of the groups is achieved through weekly meetings with the teaching staff. Written examination (50% of the final mark)
Language of instruction	Greek
Course URL	

Chemical Engineering Processes Laboratory II

Course title	**Chemical Engineering Processes Laboratory II**
Course code	**CHM_846**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	4th
Semester	8th
ECTS credits	3
Names of the lecturers	Michael E. Kornaros Christakis A. Paraskeva
Learning outcome	After completing this course a student should be able to: i) understand the use of Chemical Oxygen Demand and Biochemical Oxygen Demand as measurements of the organic content of a wastewater sample ii) have a greater understanding of the growth stages of a microbial culture and the procedure to be followed for the estimation of kinetic parameters of growth iii) learn to operate experimental laboratory or semi-pilot devices, iv) present their results in original technical reports and process of measurements exploiting the knowledge gained in their respective theoretical courses.
Competences/Skills	At the end of the course the student will have further developed the following skills/competences: a) Familiarity with the operation of laboratory and semi-pilot devices b) Get experimental results and make the appropriate calculations, Evaluation of the results c) ability to perform accurate measurements of Chemical Oxygen Demand and Biochemical Oxygen Demand in unknown wastewater samples d) ability to estimate the most important kinetic parameters of microbial growth e) Apply knowledge of subjects such as Fluid Mechanics, Heat Transfer, Physical Processes, Biochemical Process, Water and Wastewater Treatment Methods, in calculations required by each laboratory exercise.
Prerequisites	There are no prerequisites for this course. However, students should have basic knowledge of unit operations and biochemical processes.
Course contents	The Chemical Engineering Processes Laboratory II includes 5 exercises, two of which are based on unit operations (supervised by Prof. Chr. Paraskeva) and three based on biochemical processes (supervised by Prof. M. Kornaros). All exercises are performed by students groups in teams of four.

	The exercises based on Unit Operations are: U1. Flow in a network of pipelines U2. Heat exchanger **The exercises based on Biochemical Processes are:** B1. Measurement of chemical oxygen demand B2. Measurement of biochemical oxygen demand B3. Microbial growth **Keywords:** wastewater, organic content, microbial growth, Reynolds number, laminar and turbulent flow, overall heat transfer coefficient
Suggested reading	1. "Wastewater Engineering. Treatment and Reuse - Volume A", 4^{th} Edition, Metcalf & Eddy, Tziolas Publishing, 2006, Thessaloniki, ISBN: 960-148-109-2. Translation in Greek. 2. "Wastewater Management", G. Lyberatos and D. Vayenas, Tziolas Publishing, 2011, Thessaloniki, ISBN: 978-960-418-346-3. In Greek 3. "Chemical Engineering Processes Laboratory II Notes", M. Kornaros and Chr. Paraskeva, University of Patras' Publishing, 2011, Patras. 4. 'Fluid Mechanics', A.C. Payatakes, University of Patras' Publ., 2009, Patras.
Teaching and learning methods	Presentation of the theoretical background, experimental procedure and analysis of results for each exercise.
Assessment and grading methods	The evaluation of the exercises of **Biochemical Processes** is as follows: 1. Assessment of each student's performance during each exercise implementation and oral examination (50% of the final mark) 2. Written examination (100% of the final mark) The evaluation of the exercises of **Unit Operations** is as follows: 1. Oral examination at the beginning of exercise to see the preparation that made by the student (20%), 2. Written examination, after running all 4 exercises (theory and simple exercises) (40%), 3. Marking of the final written report (40%). In the end, the average of the five exercises summed and averaged out the course.
Language of instruction	Greek
Course URL	

Unit Operations II

Course title	**Unit Operations II**
Course code	**CHM_855**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	4^{th}
Semester	8^{th}
ECTS credits	6
Name of the lecturer	Dimitrios S. Mataras
Learning outcome	Students must be able to perform complex pipe flow calculations including pumps and heat transfer equipment.
Competences/Skills	Basic chemical engineering calculations
Prerequisites	XM550 Fluid Mechanics, XM650 Heat Transfer
Course contents	Introduction, definitions and principles. Dimensional analysis. Fluid statics and applications. Fluid flow phenomena. Basic fluid flow equations: Mass balance, Differential and macroscopic momentum balances, Mechanical energy equation. Bernoulli equation corrections. Incompressible flow in pipes and channels. Shear stress and skin friction, friction coefficient. Laminar flow of Newtonian fluids. Velocity distribution in turbulent flow. Friction from changes in velocity or direction. Minor losses. Pipes fittings and pumps. Developed head. Suction lift and cavitation. Power consumption, pump characteristics. Heat transfer by conduction. Principles of heat flow in fluids. Typical heat exchange equipment. Energy Balances. Heat flux and heat transfer coefficients. Mean fluid temperature. Overall heat transfer coefficient, Logarithmic Mean Temperature Difference. Individual heat transfer coefficients and calculation of the overall heat transfer coefficient. Fouling factors. Heat transfer to fluids without phase change: forced convection in laminar and turbulent flow. Heat transfer equipment. Single pass and multi pass cell and tube heat exchangers. **Keywords:** Flow in pipes, Pumps, Heat Exchangers
Suggested reading	1) Unit Operations of Chemical Engineering (7^{th} edition). W. L. McCabe, J. C. Smith, P. Harriott. McGraw-Hill, ISBN 007-124710-6 2) Βασικές Διεργασίες Χημικής Μηχανικής ($6^{η}$ έκδοση). W. L. McCabe, J. C. Smith, P. Harriott, Εκδόσεις Τζιόλα. ISBN-978-960-8050-77-8 (Translation in Greek) 3) eclass: Lecture presentations and additional materials

Teaching and learning methods	Includes 2 hr/week lectures using computer presentations, 2 hr/week problem solving and 2 hr/week laboratory sessions using UNISIM software. Instructor accessible for at least 1 hr/week for office consultation or anytime through eclass/email.
Assessment and grading methods	A) periodic tests (20%) B) Lab homework (30%) B) Written examination
Language of instruction	Greek
Course URL	https://eclass.upatras.gr/courses/CMNG2120

Industrial Chemical Technologies

Course title	**Industrial Chemical Technologies**
Course code	**CHM_835**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	4^{th}
Semester	8^{th}
ECTS credits	5
Name of the lecturer	D. Spartinos
Learning outcome	1. The understanding of Inorganic and Organic Chemical Technologies which are not included in other courses' contents of the undergraduate study program, with great emphasis on flow sheets. 2. The combination of theoretical knowledge with practice. In this context, the students realize projects on Chemical Technologies after visiting Chemical Industries.
Competences/Skills	At the end of the lesson, the students will have developed the following competences: 1. Understanding of basic Inorganic and Organic Chemical Technologies. 2. Understanding of industrial flow sheets. 3. Bringing students into contact with the Chemical Industry and understanding of the production process, the history of the field and the company, the economic condition, the quality of the products, the health and safety of the employees and the impact on the environment.
Prerequisites	There are no formal prerequisite courses. Basic knowledge by the following courses is necessary: Mass and Energy Balances, Unit Operations, Chemical Reaction Engineering.

Course contents	1. Energy and raw materials in Chemical Industry • The basic processes of Chemical Industry • Water in Chemical Industry 2. Production of O_2, N_2 and H_2-Reforming of CH_4 • Electrolytic decomposition of H_2O • Reforming of CH_4 3. Production of NH_3 and HNO_3 • Production of dilute HNO_3 in low and high pressure units • Production of concentrated HNO_3 4. Production of SO_2 and H_2SO_4 • Production of SO_2 • Oxidation of SO_2 • H_2SO_4 production unit 5. Fertilizers industry • Phosphoric fertilizers • Nitrogen fertilizers • Potassium fertilizers • Complex and Mixed fertilizers 6. Cement industry • Portland cement • Hydration of Portland cement • Pozolanic cement 7. Oils and fats industry • Production processes of seed-oils • Refinment and hydrogenation of oils • Butter, olive oil 8. Soap and detergents industry • Soaps, Glycering, Detergents 9. Food and beverages industry • Categories of food processes • Alcoholic fermentation • Production industries of wine, beer and alcoholic drinks • CH_3CH_2OH production industries 10. Paper industry • Wood products • Pulp production • Paper production **Keywords:** Industry, Chemical Technology, Production
Suggested reading	1. A. Th. Sdoukos, F. I. Pomonis, Inorganic Chemical Technology, Publications Tziolas (2010), in Greek. 2. N. Klouras, Basic Inorganic Chemistry, Publications Travlos (2002), in Greek. 3. D. Spartinos, Notes of Organic Chemical Technology (2012), in Greek.

	4. G. T. Austin, Shreve's Chemical Process Industries, 5th ed., McGraw-Hill Book Company, New York (2008).
Teaching and learning methods	Teaching of technologies included in the course contents using slides. Visits by groups of students to chemical industries.
Assessment and grading methods	1. Team projects about industries (30%). 2. Presentation of projects (20%). 3. Written examination (50%).
Language of instruction	Greek
Course URL	https://eclass.upatras.gr/courses/CMNG2109

Business Administration

Course title	**Business Administration**
Course code	**CHM_891**
Type of course	Elective
Level of course	Undergraduate
Year of study	4th
Semester	8th
ECTS credits	3
Name of lecturer	Stavros Goutsos (Department of Mechanical Engineering and Aeronautics)
Learning outcomes	1. Define the concept of programming and describe programming plans and their content. 2. Describe the basic types of compartmentalization and organizational charts. 3. Describe the types of leadership behavior. 4. Describe the incentive process. 5. Define the concept of control and its relationship with programming. 6. Present the characteristics of the efficient control.
Competences	At the end of this course the student is expected to develop the following competences: 1. Ability to prepare an action plan for a company, with alternative scenarios. 2. Ability to propose an organizational chart which will be in correspondence with the action plan. 3. Ability to discuss alternative leadership models. 4. Ability to design a control system, suitable for the action plan.
Prerequisites	There are not prerequisite courses.

Course contents	Introduction to Business administration. The firm as a system. The dynamics of the interaction with the external and the internal environment. The functions of management: Programming: Process, Plans, SWOT and PEST analysis. Organizing: Principles of organization, organizational charts, description of a work position. Directing: Models of directing, Incentive schemes, Leadership. Controlling: Basic principles of controlling systems, models of control systems. Case studies. **Key-words** Firm, Open system, Programming, Organizing, Directing, Controlling.
Recommended reading	1. Montana P., Charnov B.. "Μάνατζμεντ", Αθήνα, Εκδόσεις Κλειδάριθμος, 2005. 2. Παπαδάκης Β., "Στρατηγική των επιχειρήσεων: Ελληνική και Διεθνής Εμπειρία", Αθήνα, Εκδόσεις Ε. Μπένου, 1999. 3. P. Robbins, D. A. Decenzo, M. Coulter, "Διοίκηση Επιχειρήσεων", Αθήνα, Εκδόσεις ΚΡΙΤΙΚΗ, 2012.
Teaching and learning methods	Lectures with the aid of Power Point slides, in combination with traditional use of the board to present case studies. Lectures' slides are disposed to students in electronic form and additional educational material, such as review questions and case studies.
Assessment and grading methods	Final written exam, including questions and exercises on organizational charts.
Language of instruction	Greek
Course URL	http://www.mech.upatras.gr/~goutsos/Dioikhsh/index.html

Practical Training in Industry & Enterprises

Course title	**Practical Training in Industry & Enterprises**
Course code	**CHM_898**
Type of course	Elective
Level of course	Undergraduate
Year of study	4th
Semester	8th
ECTS credits	3
Name of lecturer	George N. Angelopoulos

Course description	The continuous and rapid scientific and technological developments in the field of Chemical Engineering create increased demands for full and comprehensive training of students. Summer internships provide students with valuable work as well as networking experience. In the Chemical Engineering Department, practical training (job internship) is active from the mid-1980s. In 1993 became an elective course. Internships can be important assets to students' overall educational experience as often help them to confirm their career interests and build their resume. Moreover in some cases, can lead to full-time employment. Internships provide a hands-on opportunity in a professional setting and help students to develop soft skills and/or improve their technical skill within a practical and professional environment. Additionally, students develop important for their professional career real-world skills such as knowing how to make a good impression, communicate with others and be an organized and respected employee. Likewise, undergraduate students pursuing research opportunities enrich their academic experience and build a competitive edge in the job market. In summary, a student can benefit from an internship as follows: • Gain work experience and develop skills • Earn course credit • Get reward • Experience a prospective career path • Gain practical experience, by applying methods and theories learned in classes • Network with professionals of the field, for references and future job opportunities • Develop new skills and refine others • Gain confidence in their abilities Within this frame, students can get an internship in companies, industries or organizations of public or private-sector or research institutions with activities related to the subject of chemical engineering. The duration of the internship can be minimum one (1), one and a half (1.5) or maximum two (2) months and depends on the agreement with the institution. Internship are available during sophomore and senior years although is a course of the 8th semester. The internship coordinator of the Department, with another two faculty members and a person from the administration: • Assist students with their internship preparation and finding an internship. • Work with the students to improve their interviewing techniques, sharpen their résumé writing skills, and direct them to the internship opportunities that match their interests and professional goals.

	Students can locate an internship by their own or to take advantage of the existing data base of collaborating companies (more than 250) which is updated every year. Furthermore they can get support from the specifically dedicated Office “Job Practice” of the University which assists students with locating internship and research opportunities. Students may also conduct an internship in another country in the frame of the Erasmus+ Programme

Economics for Non-Economists

Course title	**Economics for Non-Economists**
Course code	**CHM_899**
Type of course	Elective
Level of course	Undergraduate
Year of study	4th
Semester	8th
ECTS credits	3
Name(s) of lecturer(s)	It will not be taught

Management Information Systems I

Course title	**Management Information Systems I**
Course code	**XM881**
Type of course	Elective
Level of course	Undergraduate
Year of study	4th
Semester	8th
ECTS credits	3
Name of lecturer	Nikos Karacapilidis (Department. of Mechanical Engineering and Aeronautics)
Learning outcomes	This course provides students with an introduction to Management Information Systems (MIS) and their use in contemporary business settings. The expected learning outcomes are: a) Knowledge of the fundamentals of information theory and decision making process. b) Knowledge of the interdependency between MIS and organizations, adopting a management perspective. c) Knowledge of the basic MIS components (software, databases, networking) and related technologies.

	d) Knowledge of contemporary MIS applications in diverse business settings.
Competences	At the end of this course, students are expected to develop the following competences: 1. Ability to recognize the value of MIS in achieving competitive advantage of an organization. 2. Ability to select the proper IT technologies that businesses/organizations need today to successfully accomplish their tasks. 3. Ability to support and augment decision-making processes in contemporary organizations. 4. Ability to successfully exploit the knowledge resources of an organization. 5. Ability to suggest the right approach for the development of an MIS in a specific organization.
Prerequisites	There are no prerequisite courses.
Course contents	Introduction to MIS Information Systems in Global Business Today The strategic role of MIS Information Systems, Organizations, and Business Processes Managing Information and Knowledge – Enhancing Collaboration and Decision Making MIS basic components Databases and Information Management Telecommunications and the Internet **Key-words:** Management Information Systems; Decision Making; Information Management; Internet.
Recommended reading	1. K.C. Laudon and J.P. Laudon, “Management Information Systems: Managing the Digital Firm”, Prentice Hall, 14th edition, 2015. 2. P. Wallace, “Information systems in organizations”, Saddle River, NJ: Pearson/Prentice-Hall, 2013. 3. S. Haag, M. Cummings and J. Dawkins, “Management Information Systems for the Information Age”, Second Edition, Irwin McGraw-Hill, 2000.
Teaching and learning methods	Lectures using slides (MS PowerPoint) combined with standard class teaching. A project involving, among others, literature research. Besides Notes, the students are provided with additional educational material. They are also guided in retrieving relevant information from the Internet.
Assessment and grading methods	1. Final written exams 2. Project (on volunteer basis).

	The written exams comprise theoretical questions and exercise solving.
Language of instruction	Greek
Course URL	http://www.mech.upatras.gr/~nikos/mis-i/

Operations Strategy

Course title	**Operations Strategy**
Course code	**CHM_882**
Type of course	Elective
Level of course	Undergraduate
Year of study	4th
Semester	8th
ECTS credits	3
Name of lecturer	Emmanuel Adamides (Department. of Mechanical Engineering and Aeronautics)
Learning outcomes	1. Understand the strategic role of production units within private and public organizations. 2. Understand the strategic objectives of the production operation function in different contexts. 3. Knowledge of the organizational characteristics that determine the strategic role and the performance of a production system. 4. Knowledge of the dynamics of the decision areas of operations strategy: management of capacity, development and management of supply network, management of process technology, and design and management of organizational structures and knowledge processes for achieving specific operations objectives. 5. Knowledge of performance management of production/operations.
Competences	At the end of this course the student is expected to develop the following competences: 1. Ability to analyze issues that concern the operations and competitive strategy of industrial organizations using systemic methods. 2. Ability to design and implement performance management systems for industrial firms. 3. Ability to perform and lead a product costing project.
Prerequisites	Basic knowledge of Business Administration and Production Management is required. A short introductory 4-hour course is offered at the beginning of the semester to bring the students to the same level.

Course contents	Corporate, competitive and functional strategies – Market-based and resource-based approaches to strategy – Operations strategic objectives and decision areas – The product/process interface and its management – The strategic management of capacity – Supply chain management – Process technology management – Organization and learning processes – Performance measurement and improvement – Activity Based Costing
Recommended reading	1. Slack, N.M and Lewis, M. (2011), Operations Strategy (3rd edition), FT-Prentice Hall, Harlow. 2. Hill, A. and Hill, T. (2009), Manufacturing Operations Strategy: Texts and Cases, Palgrave Macmillan, Basingstoke. 3. Beckman, S.L. and Rosenfield, D.B. (2008), Operations Strategy: Competing in the 21st Century, McGraw-Hill, Boston.
Teaching and learning methods	Lectures (3hrs/week) using Powerpoint slides and videos. Workshop for familiarizing students with system dynamics simulation modeling.
Assessment and grading methods	1. Semester project 2. Written examination
Language of instruction	Greek
Course URL	http://www.mech.upatras.gr/~adamides/dpe/page-12.html

Technology – Innovation -Entrepreneurship

Course title	**Technology - Innovation - Entrepreneurship**
Course code	**CHM_883**
Type of course	Elective
Level of course	Undergraduate
Year of study	4th
Semester	8th
ECTS credits	3
Name of lecturer	Emmanuel Adamides (Department. of Mechanical Engineering and Aeronautics)
Learning outcome	1. Understanding technology as a socio-economic phenomenon. 2. Understanding technology as provider of competitive advantage. 3. Understanding the role of technology in products and production processes.

	4. Knowledge of the characteristics of technology start-ups and understanding of their importance for the economy. 5. Understanding the role of technological innovation in economic development. 6. Knowledge of the basic approaches and tools used for technological innovation policy making. 7. Knowledge of the processes of the assessment of technological innovations. 8. Knowledge of the processes of product development and technology commercialization. 9. Knowledge of the most important processes and frameworks for the protection of intellectual property related to technological innovation (patenting) 10. Knowledge of the process of technology start-up creation and its management as far as financing, selection of location, stuffing, etc are concerned. 11. Knowledge of the development process and the content of a business plan for a technology start-up.
Competences	At the end of this course the student is expected to develop the following competences: 1. Use methods and tools for the assessment of technologies. 2. Use methods and tools for the assessment of technological innovations in products and production processes. 3. Write and support a business plan for a technology start-up (or a technology-based firm).
Prerequisites	There are no prerequisites.
Course contents	The economic and social connotations of technology – Technology policy – Technology and R&D management – Identification of technology – Selection of technology – Acquisition of technology – Commercialization of technology– Protection of technology – Theories of innovation – Innovation policy – Innovation systems and firm performance – Techno-entrepreneurship:theory and cases – How to write a business plan
Recommended reading	1. Bessant, J. and Tidd, J. (2011), Innovation and Entrepreneurship (2nd ed), John Wiley & Sons, Chichester. 2. Cetindamar, D. Phaal, R. and Probert, D. (2010), Technology Management: Activities and Tools, Palgrave, Basingstoke. 3. Geels, F.W. (2005), Technological Transitions and System Innovation: Co-evolutionary and Socio-Technical Analysis, Edward Elgar, Cheltenham.
Teaching and learning methods	Lectures (3hrs/week): use of whiteboard, Powerpoint slides and videos for presenting the theory and practice of technological innovation and technoentrepreneurship. Extensive use of case studies.
Assessment and grading methods	3. Semester project 4. Written examination
Language of	Greek

instruction	
Course URL	http://www.mech.upatras.gr/~adamides/dpe/page-14.html

5th Year – 9th Semester

Applications of Partial Differential Equations

Course title	**Applications of Partial Differential Equations**
Course code	**CHM_E12**
Type of course	Elective
Level of course	Undergraduate
Year of study	5th
Semester	9th
ECTS credits	4
Name of the lecturer	Panayiotis Vafeas
Learning outcome	At the end of this course the student should be able to: 1. Have a good understanding of the knowledge of the basic applied mathematics for engineers, within the wide area of the partial differential equations, which is adequate to his/her science. 2. Know the new notions in the form of definitions and theorems that concern the basic contents of the course "Applications of Partial Differential Equations", in order to be able to apply them. 3. Combine and make worthy of the knowledge that he/she acquired to other fields of the theoretical and applied mathematics, in which certain notions and principles of the present course are necessary and useful.
Competences/Skills	At the end of the course the student will have further developed the following skills and competences: 1. Ability to demonstrate knowledge and understanding of essential concepts, principles and applications that are related to the partial differential equations of elliptic, parabolic and hyperbolic type. 2. Ability to apply such knowledge to the solution of problems in other fields of the wide conception of theoretical and applied mathematics, related to the science of Chemical Engineering, or to the solution of multidisciplinary problems. 3. Study skills needed for continuing profession development.
Prerequisites	There are no prerequisite courses. It is, however, recommended that students should have the basic knowledge of the differential and integral calculus of one and many variables, of the vectors analysis, as well as of the linear algebra, which they were taught to the corresponding courses "Single Variable

	Calculus and Linear Algebra" and "Multivariable Calculus and Vector Analysis". Moreover, it is requisite the basic knowledge in subjects of ordinary and partial differential equations, which they were taught to the corresponding courses "Ordinary Differential Equations" and "Partial Differential Equations".
Course contents	Differential equations with partial derivatives of second order with applications to modern technology and mathematical physics. Elliptic type equations and boundary value problems. Laplace's and Helmholtz's equations, main method of separation of variables and eigenexpansions in Cartesian, polar, cylindrical and spherical coordinates, spherical harmonic functions and applications to physical problems with the use of Bessel's and Legendre's special functions. Spatial Fourier's transform, fundamental solutions and Green's functions, integral representations. Parabolic type equations (diffusion equation) and hyperbolic type equations (wave equation) with applications in physics. Initial and boundary value problems, method of separation of variables and solution with the use of integral transforms. Non homogeneous problems of parabolic and hyperbolic type, basic methods of dealing with such problems.
Recommended reading	1. P.M. Hatzikonstantinou, "Mathematical Methods for Engineers and Scientists: Partial Differential Equations, Fourier Series & Boundary Value Problems – Complex Functions", P.M. Hatzikonstantinou Publications, Patras, 2014 (Eudoxos / code **33362174**). 2. S. Trachanas, "Partial Differential Equations", Institute of Tecnology & Research – University of Crete Publications, Herakleion, 2009 (Eudoxos / code **228**).
Teaching and learning methods	1. Teaching (2 hours/week): lectures using blackboard of the theory and its application to typical mathematical problems of Chemical Engineering. 2. Recitation (1 hour/week): solving on the blackboard exercises concerning mainly mathematical applications of the science of Chemical Engineering.
Grading methods	Written examination (100% of the final mark).
Language of instruction	Greek
Course URL	

Heterogeneous Catalysis

Course title	**Heterogeneous Catalysis**
Course code	**CHM_E36**
Type of course	Elective
Level of course	Undergraduate

Year of study	5th
Semester	9th
ECTS credits	4
Name of the lecturer	Symeon Bebelis
Learning outcome	1. Knowledge of the fundamentals of thermodynamics and kinetics of the heterogeneous catalytic reactions. 2. Knowledge of the basic types of solid catalysts as well as of the most common methods used for their synthesis, characterization and assessment of performance. 3. Knowledge of how chemisorption of reacting species is achieved on catalyst surfaces, for broad categories of solid catalysts. 4. Knowledge of the most common experimental techniques used for detection, identification and quantification of adsorbed species, with focus on the principles underlying each of these techniques and the information that may be obtained. 5. Knowledge at the microscopic level of the general mechanism and of the basic aspects of the catalytic action, for different types of solid catalysts. 6. Knowledge of the contribution of Heterogeneous Catalysis and of the key features of the catalytic actions in selected processes of industrial and environmental significance.
Competences/Skills	At the end of this course the student is expected to develop the following competences: 1. Ability to analyze experimental data of physisorption and chemisorption on solid catalyst surfaces, mainly aiming to determination of the specific surface area and of the dispersion of the active phase, respectively. 2. Ability to identify the basic macroscopic features of the mechanism of a heterogeneous catalytic reaction, on the basis of kinetic measurements. 3. Ability to select the most suitable general category of heterogeneous catalysts for a particular reaction. 4. Ability to combine measurements of catalytic activity and selectivity with results coming from the application of techniques of characterization of solid catalysts in order to convey information about the basic features of the underlying catalytic action.
Prerequisites	There are no prerequisite courses. The students should have a basic knowledge of General and Inorganic Chemistry, Organic Chemistry, Physical Chemistry and Chemical Thermodynamics and Kinetics.
Course contents	Introduction to Catalysis. Thermodynamics and kinetics of surface catalyzed reactions.

	Basic physical forms of catalytic surfaces: Metal catalysts, microporous solids, supported liquid phase catalysts, immobilized and anchored catalysts, grafted catalysts, mixed oxide catalysts. Synthesis and characterization of solid catalysts. Chemisorption processes at solid surfaces: Metal surfaces, redox oxide surfaces, solid acid surfaces. The detection of adsorbates on catalyst surfaces. Techniques used to investigate phenomena at solid surfaces (TPD, TPR, SIMS, LEED, EELS, AES, UPS, XPS, EXAFS, IR and IRAS). General principles underlying each of these techniques and examples of their application in Heterogeneous Catalysis. Catalytic actions on solid surfaces: Reactions catalyzed by transition metals, oxidation reactions on redox catalysts, hydrocarbon conversions on solid acid surfaces, reforming catalysts. Fundamental aspects of the catalytic action in heterogeneous catalytic processes of industrial and environmental significance: Hydrogenation of vegetable oils. Ammonia and nitric acid production. Methanol synthesis. Synthesis gas conversion processes. Ethylene oxide production. Sulphuric acid production. Linear polyethylene production. Catalytic cracking. Synthetic gasoline production. Catalytic processes with modified zeolite catalysts. Catalytic processes for pollution abatement. **Keywords:** Heterogeneous Catalysis; Adsorption; Catalytic action; Catalytic processes; Catalyst characterization
Suggested reading	1. I. A. Campbell, “Catalysis at Surfaces”, Chapman and Hall, London, 1988 2. J.R.H. Ross, “Heterogeneous Catalysis: Fundamentals and Applications”, Elsevier B.V., Amsterdam, 2012 3. J.M. Thomas, W.J. Thomas, “Principles and Practice of Heterogeneous Catalysis”, VCH, Weinheim, 1997. 4. I. Chorkendorff, J. W. Niemantsverdriet "Concepts of Modern Catalysis and Kinetics, 2^{nd} Edition, Wiley-VCH, Darmstadt, 2007 5. R.A. van Santen, P.W.N.M. van Leeuwen, J.A. Moulijn, B.A. Averill (editors), “Catalysis: An Integrated Approach”, 2^{nd} revised and enlarged Edition, Studies in Surface Science and Catalysis Vol. 123, Elsevier, 1999. 6. J. Hagen, “Industrial Catalysis: A Practical Approach”, 2^{nd} Edition, WILEY-VCH Verlag GmbH,Weinheim, Germany, 2006.
Teaching and learning methods	Lectures using slides (MS PowerPoint) combined with standard class teaching, mainly for solving of problems to consolidate the theoretical knowledge.

	Homework exercises or/and a small project. The latter involves, among others, literature search. Besides Notes, the students are provided with the slides of the lectures (in electronic form) as well as with additional educational material, such as publications in scientific journals. They are also guided in literature search and in retrieving relevant information from the Internet.
Assessment and grading methods	1. Final written exam 2. Mid-term written exam (on volunteer basis). The mid-term exam grade is taken into account only if it is higher than that of the final exam. 3. Homework exercises (two to three sets) or/and a small project (on volunteer basis). The written exams comprise mainly theoretical questions (part of them in the form of multiple-choice questions) but also solving of simple exercises.
Language of instruction	Greek
Course URL	https://eclass.upatras.gr/courses/CMNG2147/

Special Topics in Fluid Mechanics

Course title	**Special Topics in Fluid Mechanics**
Course code	**CHM_E56**
Type of course	Elective
Level of course	Undergraduate
Year of study	5th
Semester	9th
ECTS credits	4
Name of the lecturer	It will not be taught

Process Optimization

Course title	**Process Optimization**
Course code	**CHM_E67**
Type of course	Elective
Level of course	Undergraduate
Year of study	5th
Semester	9th
ECTS credits	4
Name of the lecturer	Ioannis K. Kookos

Learning outcome	After completing this course a student should be able to: 1. develop mathematical programming formulations for classical engineering design problems, 2. use computer software (MATLAB, GAMS) to solve process optimization problems, 3. to evaluate critically the solutions obtained using numerical software.
Competences/Skills	At the end of the course the student will have further developed the following skills/competences: 1. ability to understand the structure and analyze Process Flow Diagrams 2. ability to use numerical software such as MATLAB and GAMS in modeling optimization chemical/biochemical processes 3. ability to judge the potential viability of investment plans.
Prerequisites	There are no prerequisites for this course.
Course contents	Basic definitions and principles. Local and global optimal solutions, convexity and constraints. Necessary conditions for optimality and KKT conditions. Structure of optimization algorithms. Newton's method and quasi-Newton methods. Criteria of convergence. Linear programming (LP) and the simplex methodology for the recursive solution of LP problems. Unconstrained optimization. Optimization with constraints. 1-D and multidimentional problems. Line search. Non-linear programming with equality and inequality constraints. Successive linear programming (SLP) and successive quadratic programming (SQP). Advantages and disadvantages. Examples and applications. Modeling of discontinuous variables and decisions, integer variables. Mixed integer linear programming (MILP) and applications. Mixed integer non-linear programming (MINLP). Branch and bound method and outer approximation. Relaxation. Application to the optimization of: continuous sterilization units, multistage evaporation units, multistage compression units, bioreactors, distillation columns and heat exchangers. Introduction to MATLAB and the Optimization Toolbox. Introduction to GAMS. **Keywords**: Optimization; Optimality conditions; Algorithms; Software; Applications.
Suggested reading	I.K. Kookos & A. Koutinas, Process Optimization, Tziola Publishing, 2013. (In Greek) I.K. Kookos, Introduction to Plant Design, Tziola Publishing, 2007. ISBN: 978-960-418-173-5 (In Greek)

Teaching and learning methods	Lectures, training in using computer software and supervised completion of a design project and technical writing.
Assessment and grading methods	Design project (50% of the final mark) Written examination (50% of the final mark)
Language of instruction	Greek
Course URL	https://eclass.upatras.gr/

Molecular Spectroscopy

Course title	**Molecular Spectroscopy**
Course code	**CHM_E63**
Type of course	Elective
Level of course	Undergraduate
Year of study	5th
Semester	9th
ECTS credits	4
Name of the lecturer	Dimitris Kondarides
Learning outcome	At the end of this course the student should be able to: 1. Understand the concepts of absorption, stimulated and spontaneous emission of radiation. 2. Explain the general principles and describe the instrumentation of rotational and vibrational spectroscopies. 3. Apply basic concepts to predict the appearance of microwave, IR and UV-vis spectra of organic and inorganic molecules. 4. Show familiarity with character tables and symmetry group operations, and distinguish between infrared and Raman active vibrations. 5. Apply molecular spectroscopy in research experiments to determine appropriate experimental methods that are most relevant to a specific problem.
Competences/Skills	At the end of the course the student will have further developed the following skills/competences: 1. Ability to identify and explain the nature of the transitions induced when specific wavelengths of light interact with molecules. 2. Ability to analyze molecular spectroscopic data and conduct calculations relating to the physical properties of molecules. 3. Ability to interpret spectra obtained with one or more techniques so as to deduce detailed information about the molecular structure of inorganic and organic compounds.
Prerequisites	The students should have completed successfully the course Physical Chemistry I (3rd semester).

Course contents	**Introduction to Molecular Spectroscopy.** The electromagnetic spectrum. Interaction of light and matter. Classification of spectra: emission, absorption and Raman spectra. Experimental techniques. The intensities and widths of spectral lines. **Pure Rotational Spectra – Microwave Spectroscopy.** Rotational constant, moment of inertia and rotational energy levels of diatomic molecules. Rotational transitions and selection rules. Rotational spectra of polyatomic molecules. Microwave spectroscopy. Rotational Raman spectra. **Vibrational Spectroscopy – Diatomic Molecules.** The vibrations of diatomic molecules. The harmonic oscillator. Selection rules and infrared spectra of diatomic molecules. Anharmonicity. Vibration-rotation spectra. Vibrational Raman spectra. **Symmetry.** The symmetry elements of objects. Symmetry operations. The symmetry classification of molecules. Introduction to the group theory. **Vibrational Spectroscopy – Polyatomic Molecules.** The vibrations of polyatomic molecules. Normal modes and symmetry. Infrared spectra and vibrational Raman spectra of polyatomic molecules. Applications of symmetry and group theory in spectroscopy. **Electronic Spectroscopy.** Electronic structure of molecules. Characteristics of electronic transitions. The Frank-Condon principle. UV/vis spectroscopy. Measures of intensity; the Beer-Lambert law. Introduction to Lasers. General principles of laser action.
Suggested reading	1. P.W. Atkins and J. de Paula, "Physical Chemistry", 9th Edition, Oxford University Press, 2010. 2. D.A. McQuarrie, J.D. Simon, "Physical Chemistry: A Molecular Approach", D.A. McQuarrie, J.D. Simon, University Science Books, Sausalito, California, 1997. 3. H. Kuhn, H.-D. Forsterling, D.H. Waldeck, "Principles of Physical Chemistry", 2nd Edition, John Wiley & Sons, Inc., 2000.
Teaching and learning methods	PowerPoint presentations.
Assessment and grading methods	1. Problem-solving by the students (20% of the final mark). 2. Written examination (80% of the final mark).
Language of instruction	Greek
Course URL	

Process Control

Course title	**Process Control**
Course code	**CHM_E66**
Type of course	Elective
Level of course	Undergraduate
Year of study	5^{th}
Semester	9^{th}
ECTS credits	4
Name of the lecturer	It will not be taught
Learning outcome	After completing this course a student should be able to: 1. Have a general understanding of state space methods for the design of control systems based on a model of process dynamics. 2. Understand the concepts of controllability and observability, as well as their significance in state feedback control and state estimation. 3. Calculate state feedback gains and observer gains with given eigenvalue specifications. 4. Combine state feedback with state observer to construct an output feedback control law. 5. Optimally select state feedback and state observer gains.
Competences/Skills	At the end of the course the student will have further developed the following skills/competences: 1. Ability to design feedback control systems based on a model of process dynamics. 2. Ability to use MATLAB for control system design calculations.
Prerequisites	There are no formal prerequisites. However, students are advised to take the basic course on process dynamics and control (XM840) prior to taking this course.
Course contents	STATE SPACE ANALYSIS OF LINEAR SYSTEMS. State space description of linear systems; response calculation using the exponential matrix function. State variable transformations. Input/output behavior in the time domain and in the Laplace domain. Transfer function. Poles and zeros. Stability of linear systems. Series and parallel connections of linear systems in state space. State feedback control versus output feedback control. State space description of closed loop dynamics. CONTROLLABILITY AND OBSERVABILITY. The notion of controllability and its significance. Decomposition of a linear system into a controllable and an uncontrollable part. Proportional state feedback: gain selection for pre-assigned closed loop eigenvalues. The notion of observability and its significance. Decomposition of a linear system into an

	observable and an unobservable part. Open loop observer, Luenberger observer. Selection of Luenberger observer gains for pre-assigned eigenvalues of the error dynamics. Reduced order observer and eigenvalue assignment. MODEL BASED OUTPUT FEEDBACK CONTROL. General form of output feedback controller. Steady state analysis of the closed loop system - conditions for zero steady state error. Observer-state feedback. Observer-state-plus-residual feedback. Eigenvalue separation property. OPTIMAL STATE FEEDBACK – OPTIMAL STATE ESTIMATION. Quadratic performance indexes for a control system. Optimal sate feedback gain calculation via the algebraic Riccati equation. Hamiltonian system - optimal closed loop eigenvalues. Optimal state observer. **Keywords - basic terms**: State space description and analysis, controllability, observability, state feedback, state observer, eigenvalue separation.
Suggested reading	B. Friedland, "Control System Design: An Introduction to State-Space Methods", Dover, 2005. C.-T. Chen, "Linear System Theory and Design", 4th ed., Oxford, 2012.
Teaching and learning methods	Lectures, problem-solving.
Assessment and grading methods	Written examination, homework problems.
Language of instruction	Greek
Course URL	

System Dynamics

Course title	**System Dynamics**
Course code	**CHM_E68**
Type of course	Elective
Level of course	Undergraduate
Year of study	5th
Semester	9th
ECTS credits	4
Name of the lecturer	Stavros Pavlou
Learning outcome	Introduction to nonlinear dynamical systems and methods of analyzing their behavior.

Competences/Skills	At the end of the course the students will be familiar with the basic analytical methods of studying dynamical systems.
Prerequisites	Knowledge of mathematics, especially differential equations.
Course contents	**ORDINARY DIFFERENTIAL EQUATIONS**. Existence and uniqueness of solution. Integral curves and trajectories. Equilibrium points of autonomous systems. **SOLUTION OF LINEAR SYSTEMS OF ORDINARY DIFFERENTIAL EQUATIONS**. General solution. Solution of systems with constant matrix. **STABILTY OF LINEAR SYSTEMS OF ORRDINARY DIFFERENTIAL EQUATIONS.** Autonomous linear systems. Non-autonomous homogeneous linear systems. **PHASE-SPACE ANALYSIS**, Two-dimensional linear system. Linear systems of higher dimensions. Non-linear systems and Lyapunov's First Theorem. The problem of imaginary eigenvalues. Non-elementary equilibrium points. Other characteristics of phase space. **STABILITY ANALYSIS OF NON-LINEAR SYSTEMS**. Stability of equilibrium points of non-linear systems. Direct methods of stability analysis and Lyapunov's Second Theorem. **LIMIT CYCLES**. Locating limit cycles. Poincaré map and stability of limit cycles. Stability of fixed points of maps. Analysis of stability characteristics of limit cycles. **BIFURCATION THEORY**. Structural stability and bifurcations. Bifurcations of equilibrium points of systems of differential equations. Bifurcations of fixed points of maps and of limit cycles of systems of differential equations. Global bifurcations. **CHAOTIC DYNAMICS**. Strange attractors. Lyapunov exponents. Chaotic behavior of maps. Dimentionality of strange attractors. Roads to chaos. **SPECIAL TYPES OF SYSTEMS**. Gradient-flow systems. Conservative systems.
Suggested reading	S. Pavlou, *System Dynamics*, University of Patras (2004) (in Greek). W. E. Boyce and R. C. DiPrima, *Elementary Differential Equations*, 7th edition, John Wiley & Sons (2000). J. Gleick, *Chaos: Making a New Science*, Penguin (1988)
Teaching and learning methods	Lectures and weekly homework exercises.
Assessment and grading methods	Written exam (80% of the final grade) and homework exercises (20% of the final grade).
Language of instruction	Greek
Course URL	http://www.chemeng.upatras.gr/en/content/courses/en/system-dynamics

Rheology of Polymers

Course title	**Rheology of Polymers**
Course code	**CHM_E50**
Type of course	Elective
Level of course	Undergraduate
Year of study	5th
Semester	9th
ECTS credits	4
Name of the lecturer	Yiannis Dimakopoulos
Learning outcome	At the end of this course the student is expected to have obtained a deep understanding of the different rheological behavior of systems with a complex microstructure, with particular emphasis on fluids composed of long macromolecular chains. The student is expected to have learnt how this behavior is encoded in the form of constitutive laws describing the response of their internal structure to the imped flow field. Also, how these constitutive laws are solved in order to provide information for the corresponding material functions in a given flow. The student will also be familiarized with the basic concepts and scaling law predictions of some very important molecular theories for the dynamics of polymers. We mention the Rouse theory, the Zimm model, the reptation theory by Doi-Edwads and de Gennes, and their extensions to account for new polymer architectures or formulations (branched, ring, bidisperse, networks, micelles, colloids, biopolymers, etc).
Competences/Skills	At the end of the course, the student should be able to: 1. know how the unique rheological behavior of a polymeric fluid is encoded through the definition of material functions (which are defined differently for different flows, such as shear and elongation) 2. actually use rheological constitutive laws to extract expressions for the these material functions and then use them to describe available experimental data 3. fit experimental data for the linear viscoelasticity of on the generalized Maxwell model and extract the characteristic relaxation spectrum of the fluid 4. how to make master viscosity curves by applying the time-temperature superposition principle 5. know the scaling laws derived from the most important polymer dynamics theories (Rouse and reptation) to explain rheological measurements

Prerequisites	Good knowledge of Thermodynamics (1 semester course is enough) and very good knowledge of Physical Chemistry I (taught in our Department one semester earlier)
Course contents	1. Vector and tensor analysis. Their usefulness in rheology and fluid mechanics (quick overview). The stress tensor and its interpretation. 2. Newtonian behavior. Generalized Newtonian behavior. 3. Non-Newtonian behavior (demonstration through experiments). Introduction to polymer viscoelasticity. 4. Material functions: shear and extensional viscosity, normal stresses, stress relaxation modulus, loss modulus, storage modulus, creep compliance, etc. 5. The first phenomenological models. Maxwell, Voigt and Jeffreys models. The generalized (multi-mode model) linear viscoelastic model. 6. Applications of the generalized linear viscoelastic model to the following flows: shear, stress relaxation, stress growth, constrained recoil, small amplitude oscillatory shear, and creep. Analytical derivation of the corresponding material functions. 7. Fitting of experimental rheological data onto the generalized Maxwell model. Time-temperature superposition principle. 8. Other viscoelastic models (based on continuum mechanics): Oldroyd-B, Giesekus, Phan-Thien/Tanner (PTT). Viscometric functions of these models in the shear and extensional flows. 9. Introduction to molecular theories for polymer dynamics: dumbbell model, Rouse theory, Zimm theory, reptation theory and the tube model, recent extensions of the tube model, network models.
Suggested reading	1. R.G. Larson, Constitutive Equations for Polymer Melts and Solutions (Butterworth-Heinemann, London, 1988). 2. R.B. Bird, R.C. Armstrong, and O. Hassager, Dynamics of Polymeric Liquids; Vol. 1, Fluid Mechanics, 2nd Ed. (John Wiley & Sons, New York, 1987a). 3. R.B. Bird, C. F. Curtiss, R.C. Armstrong, and O. Hassager, Dynamics of Polymeric Liquids; Vol. 2, Kinetic Theory, 2nd Ed. (John Wiley & Sons, New York, 1987b).
Teaching and learning methods	The instructor prefers teaching by writing a lot on the blackboard
Assessment and grading methods	Weekly homework sets, midterm exam, final exam
Language of instruction	Greek
Course URL	

Biomechanics I

Course title	**Biomechanics I**
Course code	**CHM_E57**
Type of course	Elective
Level of course	Undergraduate
Year of study	5th
Semester	9th
ECTS credits	4
Names of lecturers	G. Athanassiou, D. Deligianni, D. Mavrilas (Department of Mechanical Engineering & Aeronautics)
Learning outcomes	This course is an introduction to the mechanical behavior of biological tissues and systems. The aims of the course are to: • Develop an understanding of the important issues regarding the application of engineering tools in the study of biological tissue mechanics. • Provide the students with an appreciation for the mechanical complexity of biological systems. • Understand the forces and stresses that are applied or developed on parts of the human body, and the outcomes of these loads.
Competences	At the completion of this course it is desired that each student be able to: • Apply the laws and principles of engineering in the study of biological systems. • Quantify the cause and effect of relationship between force and strain or linear and angular motion. • Make free-body diagrams for the calculation of loads or reactions in the muscles and the joints.
Prerequisites	There are no prerequisite courses. The students should have a basic knowledge of Mechanics of Deformable Solids, Strength of Materials and Fluid Mechanics.
Course contents	Introduction to biomechanics principles, Structural elements of the human body. Biomechanics of the musculoskeletal system - bones, muscle: Basic anatomy and physiology, Mechanical functions, Physiological functions, Composition, Microscopic-macroscopic structure, Tissue mechanical characteristics, Bone fracture and remodeling, Mechanical adaptation. Muscle contraction and its modeling, Kinematics elements, Musculoskeletal modeling. Biomechanics of soft connective tissues (SCT): Anatomy – histology of SCT. Biopolymers composing SCT (collagen,

	elastin, proteoglycans, glycosaminoglycans). Mechanics of SCT, static & dynamic, correlation with its components and structure. Mathematical modeling of SCT mechanics. Biomechanics of blood circulation:_Anatomy and physiology. The heart as a pump. Circulation fluid dynamics. Systemic circulation in arteries, veins, bifurcations. Blood-Vessel interaction. Mechanical characteristics of cardiovascular implants (heart valves, vessels). Blood flow equations, blood flow dynamics. Respiratory system. Artificicial oxygenation, extracorporeal blood circulation. Kidneys, artificial kidney, hemodialysis systems. Measurement techniques for pressure, strain, velocities in the human body and in artificial organs. **Keywords:** Biomechanics; Tissues; Biological systems, Mechanical behavior; Modeling, Structure-function of biological systems.
Recommended reading	Lecture notes and handouts, accessible via the Open eClass (Asynchronous Teleteaching Platform) of the University of Patras, and relevant Internet links.
Teaching and learning methods	Lectures using slides (MS PowerPoint) combined with standard class teaching, mainly for solving of problems to consolidate the theoretical knowledge. Final project involving, among others, literature search. Besides Notes, the students are provided with the slides of the lectures (in electronic form) as well as with additional educational material, such as publications in scientific journals. They are also guided in literature search and in retrieving relevant information from the Internet.
Assessment and grading methods	Final written exam. Presentation of the project (on volunteer basis).
Language of instruction	Greek
Course URL	https://eclass.upatras.gr/courses/MECH1197/

Practical Software Applications

Course title	**Practical Software Applications**
Course code	**CHM_E60**
Type of course	Elective
Level of course	Undergraduate
Year of study	5th

Semester	9th
ECTS credits	4
Name(s) of lecturer(s)	It will not be taught

Nanostructured Polymers

Course title	**Nanostructured Polymers**
Course code	**CHM_E70**
Type of course	Elective
Level of course	Undergraduate
Year of study	5th
Semester	9th
ECTS credits	4
Name of the lecturer	Georgios Staikos
Learning outcome	- Methods and polymerization technics which can be used for the synthesis of block and graft copolymers, suitable for the creation of nanostructured systems. - Study of the phase separation of block copolymers, micro-phase separation, appearance of nanostructures. - Solutions of block copolymers in selective solvents, micelle formation, adsorption on surfaces. - Exploitation of the micro-phase separation of the block copolymers for the creation of useful nanostructures.
Competences/Skills	- Familiarization with polymers and technics that can be used at advanced technological applications.
Prerequisites	- Polymer Science (XM570)
Course contents	- Controlled radical polymerizations. - Synthesis of copolymers with advanced polymerization methods. - Inhomogeneous polymerization through free radicals. Polymerization in emulsion, micro-emulsion and suspension. - Self-assembly of block copolymers. - Water-soluble polymers. Introduction. Water and aqueous solutions. Nonionic polymers. Polyelectrolytes. Biopolymers. - Water-soluble inter-polymer complexes corona-type, nanocolloids.
Suggested reading	- K.A. Davis and K. Matyajaszewsky, “Statistical, Gradient, Block and Graft Copolymers by Controlled/Living Radical Polymerizations”, Adv. Polym. Sci. 159, Springer, 2002. - N. Hadjichristidis, S. Pispas and G. Floudas, “Block Copolymers: Synthetic Strategies, physical properties and applications”, Wiley-Interscience, 2003.

	- G.A. Ozin, A.C. Arsenault and L. Cademartini, Nanochemistry: A Chemical Approach to Nanomaterials, RSC Publishing, 2nd Edition, 2009
Teaching and learning methods	- Lectures by using transparencies - Homework (Questions and problems)
Assessment and grading methods	- Written examination
Language of instruction	- Greek
Course URL	https://eclass.upatras.gr/courses/CMNG2137

Microelectronics technology

Course title	**Microelectronics Technology**
Course code	**CHM_E33**
Type of course	Elective
Level of course	Undergraduate
Year of study	5th
Semester	9th
ECTS credits	4
Name of the lecturer	Dimitrios S. Mataras
Learning outcome	Acquaintance with the specifics of Chemical and Physical processes used in microelectronics processing (CVD, PVD, MBE, Sputtering, PECVD, Etching) using the fabrication of Silicon IC's as a paradigm.
Competences/Skills	Application of reactor design and transport phenomena in the microscopic processing steps of IC fabrication.
Prerequisites	Chemical kinetics, reactor design and transport phenomena.
Course contents	Introduction. Integrated Circuits (IC). Semiconductors and charge carriers, basic relationships. Elementary IC units, diodes and transistors, device physics and operation. Outline of IC production: from sand to IC's. Metallurgical Grade Silicon production. Silicon refining, Electronic Grade Silicon. Production and refinement of chlorosilanes. Deposition of polycrystalline silicon: Siemens, fluidized bed. Crystal Growth. Czochralski (CZ), Bridgeman and floating zone methods. Overview of CZ, axial and radial distribution of dopants and oxygen. Chemical Processes. Chemical Vapor Deposition (CVD). Surface diffusion and epitaxial growth. Homogeneous and

	heterogeneous reactions and deposition kinetics. CVD reactors. Flow and heat regimes, reactor design. Doping. Incorporation and transport of dopants. Diffusion in solids, redistribution of dopants. Lithography. Basic principles and techniques. Resists and resist development. Physical and Physicochemical Processes. Evaporation (PVD) and Molecular Beam Epitaxy (MBE). Plasma Processing. Sputtering (dc, rf), sputtering rates and deposition rate. Plasma Enhanced Chemical Vapor Deposition (PECVD). Plasma Etching. PVD and Plasma reactors: specifics, electrical characteristics and design considerations. **Keywords:** Microelectronics Processing, Czochralski, CVD, PVD, PECVD, Plasma etching
Suggested reading	1) Fundamentals of Microelectronics Processing. Hong. H. Lee. McGraw-Hill. ISBN-0-07100796-2 2) Process Engineering Analysis in Semiconductor Device Fabrication. S.Middleman, A. Hochberg, McGraw-Hill, ISBN-0-07041853-5 3) eclass materials: Lecture presentations.
Teaching and learning methods	Includes 3 hr/week lectures using computer presentation, Instructor accessible for at least 1 hr/week for office consultation or anytime through eclass/email.
Assessment and grading methods	A) periodic tests B) Written examination
Language of instruction	Greek
Course URL	https://eclass.upatras.gr/courses/CMNG2103

Materials Protection Technology

Course title	**Materials Protection Technology**
Course code	**CHM_E82**
Type of course	Elective
Level of course	Undergraduate
Year of study	5th
Semester	9th
ECTS credits	4
Name of the lecturer	Victor Stivanakis
Learning outcome	*At the end of this course the student should be able to:* – understand basic corrosion principles

	– recognize the differences among the various types of corrosion, the physicochemical properties and the behavior. – understand the principles and the common methods of the metal protection.
Competences/Skills	*At the end of the course the student will have developed the following skills/competences:* – Ability to observe the corrosion phenomena and their time evolution by examining representative samples (microscopy, micrometers, stereoscope). – Ability to demonstrate knowledge and understanding of essential concepts, principles and applications that are related to the corrosion process. – Ability to apply such knowledge to the solution of problems related with corrosion – Ability to evaluate negative results rising from the corrosion. – Ability to estimate and to suggest appropriate protection methods for specific materials.
Prerequisites	There are no prerequisites.
Course contents	Basic concepts, definitions and causes of different corrosion phenomena. Corrosion of metallic and non-metallic materials. Corrosion mechanisms and protection methods. Brief presentation and classification of the surface treatment technologies. Traditional thermal and thermochemical heat treatment of steel. Methodology for their thermodynamic and kinetic study. Basic principles of the design of coatings. Basic principles of the CVD (Chemical Vapour Deposition) and PVD (Physical Vapour Deposition) processes. Presentation of applications. Methods for the industrial production of coatings. Characterization methods and tribological/mechanical properties of the coatings
Suggested reading	– Corrosion Engineering, Mars G.Fontana, Edition 1987, McGraw-Hill Book Company, ISBN 0-07-100360-6 – Διάβρωση και Προστασία Υλικών, Θ. Σκουλικίδης-Π. Βασιλείου, ISBN 978-960-7888-85-3.
Teaching and learning methods	– Lectures using power-point presentations. – Training in groups, investigation of the corrosion form in metallic specimens and selection of a research topic. – Laboratory experiments and measurements. – Presentation of the conclusions. – Conclusions, discussions and suggestions.

Assessment and grading methods	1) Group presentations at the end of the semester (70% of the final mark). 2) Written examination (30% of the final mark).
Language of instruction	Greek
Course URL	

Composite and Nanocomposite Materials

Course title	**Composite and Nanocomposite materials**
Course code	**CHM_E83**
Type of course	Elective
Level of course	Undergraduate
Year of study	5th
Semester	9th
ECTS credits	4
Name of the lecturer	Costas Galiotis
Learning outcome	After completing this course a student should be able to: - Understand the concept of composite material used in a variety of diverse applications and its physic-mechanical properties. - Understand the difference between conventional composite materials and nanocomposites. - Select the proper composite material for a variety of applications.
Competences/Skills	At the end of the course the student will have further developed the following skills/competences: - Be able to conduct professionally and with regard to their responsibilities toward society. - Be able to design and/or assess the mechanical and thermal properties of composite materials. - To propose composite materials for a number of applications.
Prerequisites	Students should have knowledge of materials science, mechanics of materials and of polymer technology.
Course contents	1. Introduction. Types of composites. Heterogeneity and anisotropy. Matrix and reinforcing agents: Materials used as matrix (polymers, metals, ceramics). Reinforcement types. Nanocomposites. 2. The interface in composites: Adhesion and interactions. Methods of interface characterization. Mechanical stresses and strains. Stress-transfer models for the interface.

	3. Preparation methods: Autoclave oven. Resin transfer moulding. Fibre winding and pultrusion. 4. Mechanical properties of composite materials: Density. Modulus of elasticity. Strength. The anisotropic nature of the fibrous composite materials. UD stiffness of composites in the fibre direction and off axis. Mechanical behaviour of laminates (symmetrical, unsymmetrical etc.). Mechanical behaviour of fibre-wound composites. Failure mechanisms. 5. Applications: Aerospace and aeronautics. Car industry and transportation. Electrical and electronic applications. Sporting goods industry. 6. Nanocomposite materials: Introductory concepts. Inclusions. The concept of the matrix modification at the nanoscale. Methods of production and dispersion of nano-inclusions (shear mixing, centrifugal mixer, extrusion etc.) into matrices (mainly polymeric). Properties (electrical, mechanical, etc.). Applications.
Suggested reading	G. Papanikolaou and D. Mouzakis, Composite Materials, Ed. Kleidarithmos, Athensς, 2007. ISBN 978-960-461-027-3
Teaching and learning methods	Lectures, Training in solving exercises
Assessment and grading methods	Non-compulsory progress exams or final written examination (100% of the final mark)
Language of instruction	Greek
Course URL	

Ceramics and Inorganic Binding Materials

Course title	**Ceramics and Inorganic Binding Materials**
Course code	**CHM_E85**
Type of course	Elective
Level of course	Undergraduate
Year of study	5th
Semester	9th
ECTS credits	4
Name of the lecturer	Victor Stivanakis
Learning outcome	*At the end of this course the student should be able to:* – have a good understanding of the technology of ceramics and cements – understand the principles and the basics of the properties of structural materials

	− understand the influence of the additions, w/c, grinding in the technological properties of the structural materials − combine and apply the knowledge obtained in the industrial production of the structural materials − have a good understanding of the environmental problems due (by) the industrial production
Competences/Skills	*At the end of the course the student have developed the following skills/competences:* − Ability to demonstrate knowledge and understanding of essential concepts, principles and applications that are related to the process of the cement and ceramic production. − Ability to investigate the pollution and the environmental problems. − Ability to propose solutions in environmental problems and in use of byproducts.
Prerequisites	There are no prerequisites.
Course contents	***Powder metallurgy***: Powder preparation methods, pressing, theory of sintering. Modern high performance ceramics (Al_2O_3, ZrO_2, SiC, Si_3N_4) and applications (heat engines, gas turbines, bioceramic bearings etc). ***Composite materials***: Cemented carbides, cermets precipitation hardened materials. Refractories, ceramic fluxes. ***Cement:*** Raw materials, exploration, burnability and clinkerisation, hydration, mechanical behavior of concrete in dependence on - cement chemistry, - grain-size, -fineness,-additives etc. The influence of several additions in technological properties of cements **Gypsum and lime**: Physical, chemical and mineralogical characteristics, exploration.
Suggested reading	Instructor notes.
Teaching and learning methods	Lectures using power-point presentations, and multimedia. Seminars in industry of cement and ceramics. Presentations
Assessment and grading methods	1) Group Presentations at the end of the semester (70% of the final mark). 2) Written examination (30% of the final mark).
Language of instruction	Greek
Course URL	

Bioreactor Analysis and design

Course title	**Bioreactor Analysis and design**
Course code	**CHM_E54**
Type of course	Elective
Level of course	Undergraduate
Year of study	5th
Semester	9th
ECTS credits	4
Name of the lecturer	Stavros Pavlou
Learning outcome	The course goes further from the course "Biochemical Processes" and consists in the introduction and study of various types of bioreactors.
Competences/Skills	At the end of this course the students will know the basic types of bioreactors and the methods of their analysis and design.
Prerequisites	It is desirable that the students have attended the class "Biochemical Processes".
Course contents	BIOREACTORS. Chemostat, Monod's model in the chemostat. Product formation. Maintenance and endogenous metabolism. Non-ideal bioreactors. Cell attachment to chemostat walls. DYNAMIC BEHAVIOR OF BIOREACTORS. Elements of system dynamics. Dynamic behavior of the chemostat. Monod's model. Andrews's model. LIMITATION OF THE MICROBIAL GROWTH RATE FROM MULTIPLE NUTRIENTS. Classification of pairs of nutrients. Complementary nutrients. Substitutable nutrients. Generalized models of microbial growth. DISTRIBUTED MODELS. Population balance of particles. Breakage process. Aggregation process. Balance of environmental components. Cell population balance in a chemostat. MIXED CULTURES OF MICROORGANISMS. Classification of microbial interactions. Direct microbial interactions. Indirect microbial interactions. Combinations of interactions.
Suggested reading	G. Lyberatos, S. Pavlou, "Introduction to Biochemical Engineering", Tziola Scientific Publications (2010) (in Greek). J. E. Bailey, D. F. Ollis, "Biochemical Engineering Fundamentals", MacGraw-Hill, New York (1986).
Teaching and learning methods	Lectures and weekly homework exercises.
Assessment and grading methods	Written exam (80% of the final grade) and homework exercises (20% of the final grade).
Language of instruction	Greek

Course URL	http://www.chemeng.upatras.gr/en/content/courses/en/bioreactor-analysis-and-design

Environmental Technology: Urban Wastewater Treatment

Course title	**Environmental Technology: Urban Wastewater Treatment**
Course code	**CHM_E92**
Type of course	Elective
Level of course	Undergraduate
Year of study	5th
Semester	9th
ECTS credits	4
Name of the lecturer	Michael E. Kornaros
Learning outcome	After completing this course a student should be able to: i) understand the characterization of a wastewater stream in terms of contained constituents (qualitative and quantitative). ii) have a greater fundamental understanding of the mechanisms involved in both physicochemical and most important in biological processes for the removal of specific constituents iii) understand, select and design the fundamental methods for the management of the biosolids resulting from the treatment of wastewater
Competences/Skills	At the end of the course the student will have further developed the following skills/competences: i) ability to identify and measure the qualitative and quantitative characteristics of wastewater streams ii) ability to design the sewage network for the collection of wastewater streams from their sources iii) ability to select, analyze and design the most appropriate wastewater treatment processes to achieve preset disposal criteria and limits iv) ability to select, analyze and design the most appropriate processes for treatment of the biosolids resulting from wastewater treatment v) ability to design the facilities for disposal or reuse of treated water and biosolids
Prerequisites	There are no prerequisites for this course. However, students should have basic knowledge of mass and energy balances, unit operations and biochemical processes.
Course contents	The problem of wastewater treatment. Wastewater flowrates and constituent loadings. Qualitative and quantitative characteristics of wastewaters. Sewage networks. Legislation and treatment levels. Pretreatment (screens, grit chambers, grease removal, flow stabilization). Primary sedimentation and flotation. Fundamentals of microbiology and microbial kinetics. Secondary treatment. The activated sludge process. Alternative secondary suspended growth systems. Biofilm systems.

	Trickling filters and biodiscs. Nutrient removal (nitrification, denitrification, biological phosphorus removal). Modelling of activated sludge systems. Natural systems for wastewater treatment. Sludge (biosolids) management. Disinfection. Physical and chemical processes for wastewater treatment. Membrane bioreactors. Industrial wastewater streams. Disposal - reuse of treated effluents. **Keywords:** wastewater, biological processes, activated sludge, disinfection, water reuse, biosolids management
Suggested reading	1. "Wastewater Engineering. Treatment and Reuse - Volume A", 4th Edition, Metcalf & Eddy, Tziolas Publishing, 2006, Thessaloniki, ISBN: 960-148-109-2. Translation in Greek. 2. "Wastewater Engineering. Treatment and Reuse - Volume A", 4th Edition, Metcalf & Eddy, Tziolas Publishing, 2006, Thessaloniki, ISBN: 960-418-113-0. Translation in Greek. 3. "Wastewater Management", G. Lyberatos and D. Vayenas, Tziolas Publishing, 2011, Thessaloniki, ISBN: 978-960-418-346-3. In Greek 4. "Wastewater Treatment ", S. Tsonis, Papasotiriou Publishing, 2004, Athens, ISBN: 960-7530-51-9. In Greek
Teaching and learning methods	Lectures, solving of exercises and problems from past exams, technical visit to a local wastewater treatment plant.
Assessment and grading methods	Written examination (100% of the final mark)
Language of instruction	Greek
Course URL	https://eclass.upatras.gr/

Biotechnology

Course title	**Biotechnology**
Course code	**CHM_E93**
Type of course	Elective
Level of course	Undergraduate
Year of study	5th
Semester	9th
ECTS credits	4
Name(s) of lecturer(s)	It will not be taught

Biomaterials

Course title	**Biomaterials**
Course code	**CHM_E94**
Type of course	Elective
Level of course	Undergraduate
Year of study	5th
Semester	9th
ECTS credits	4
Name of the lecturer	Eleftherios Amanatides
Learning outcome	At the end of this course the student should learn: 1. The meanings of biocompatibility and toxicity of biomaterials 2. The different types of biomaterials depending on the biomedical application and the most important mechanical, physicochemical and biological properties of these materials. 3. The differences between biomaterials that are designed for organs replacement, reconstruction and regeneration. 4. The most important types of proteins, cells and tissues and their mechanisms of interactions with biomaterials surfaces 5. The most important in-vitro and in-vivo test of biomaterials for monitoring their biocompatibility and toxicity 6. The most important mechanisms of cells response to wounds caused by biomaterials implantation
Competences/Skills	At the end of the course the student will have further developed the following skills/competences: 1. The ability to choose or prepare the proper biomaterial depending on the biomedical application 2. The ability to predict the response of the biological system during the interaction with different biomaterials 3. The ability to design and plan processes for surface modification of biomaterials for improvement of biocompatibility and material performance 4. The ability to choose or plan the proper in-vitro or in-vivo tests for checking and monitoring the biocompatibility of materials
Prerequisites	There are no prerequisite courses. It is, however, recommended that students should have basic knowledge of Materials Science, Polymers Science and Biology
Course contents	1. Introduction to biomaterials and biocompatibility / toxicity. 1st, 2nd and 3^{d} generation biomaterials. Replacement, Reconstruction and regeneration of basic organs 2. Types of biomaterials: Synthesis and properties of metallic, ceramic and polymeric biomaterials Mechanical and physicochemical properties

	3. Types of biomaterials: Hydrogels, Natural Biomaterials, medical fibers and textiles. Usual methods for surface modification of biomaterials. 4. Proteins – Cells – Tissues: Mechanisms of interactions with biomaterial surfaces. Cells and tissue responses to implantation wounds 5. In-vitro and in-vivo tests of materials biocompatibility 6. Application of biomaterials in ophthalmology, orthopediatrics, cardiovascular surgery and urology. 7. Choice and design of proper materials for biomedical applications
Suggested reading	1. Biomaterials Science: An Introduction to Materials in Medicine, Second Edition [electronic resource] - 2nd edition/2004 - Authors: Ratner, B. D.- ISBN: 978-0125824637, Type: Electronic book 2. Biomaterials [electronic resource], Authors: Park, Joon and Lakes, R.S., ISBN: 9780387378800, Type: Electronic book
Teaching and learning methods	1. Classes in PowerPoint that are uploaded for the students in the e-class site of the course 2. The instructor solve exercises during the classes
Assessment and grading methods	1. One project per group of one or two students in a specific biomaterials topic (50 % of final grade). The students presents their project and deliver a 10 pages summary of the project 2. Final written exams (50 % of final grade)
Language of instruction	Greek
Course URL	https://eclass.upatras.gr/courses/CMNG2117/

5th Year – 10th Semester

Electrochemical processes

Course title	**Electrochemical Processes**
Course code	**CHM_E31**
Type of course	Elective
Level of course	Undergraduate
Year of study	5th
Semester	10th
ECTS credits	4
Name of the lecturer	Symeon Bebelis
Learning outcome	The course aims to provide an introduction to the core principles and topics of modern Electrochemistry, focusing on

	thermodynamics and kinetics of charge transfer reactions at electrode/electrolyte interphases. By the end of the course the students should be able to: 1. Describe the subject and the fundamental concepts of Electrochemistry as well as the types and modes of operation of electrochemical systems. 2. Describe the different types of ionic conductors and the way the ions behave in the presence of other ions. 3. Explain how ions move in ionic conductors and describe the fundamental parameters and laws which concern charge transfer phenomena in a homogeneous electrolyte phase. 4. Describe the structure of an electrode/electrolyte interphase and explain the appearance of potential difference across it. 5. Describe the state of thermodynamic equilibrium of electrochemical systems and formulate the condition of thermodynamic equilibrium for an electrochemical reaction or an electrode/electrolyte interphase. 6. Describe the factors and mechanisms which determine the rate of an electrochemical reaction and control the operation of electrochemical systems under non-equilibrium conditions. 7. Describe the fundamentals of Electrocatalysis and of Electrochemical Promotion of Catalysis.
Competences/Skills	By the end of the course the students are expected to develop the following competencies: 1. For electrolyte solutions, ability to calculate the ionic strength, the activity coefficient of an ion species (or, the mean ionic activity coefficient), the conductivity and related parameters. For electrolyte melts and for solid electrolytes, ability to calculate the change in conductivity for a given temperature change or the activation energy for ionic conduction, from measurements of ionic conductivity. 2. Ability to write down the half-reactions and the total reaction for an electrochemical cell of a given schematic diagram and to calculate the standard electromotive force of the electrochemical cell using standard electrode potential data. 3. Ability to calculate the electromotive force of an electrochemical cell from the change of Gibbs free energy for the overall reaction in the cell, and vice versa, as well as to predict the spontaneous direction of a redox reaction using values of relative electrode potentials. 4. Ability to apply the condition of electrochemical equilibrium for an interface and for an electrochemical reaction, and to correlate the equilibrium potential of an electrode with the activities of the corresponding electroactive species.

	5. Ability to calculate the developed overpotentials during the operation of an electrochemical cell as well the operating potential of the cell for a given current density. 6. Ability to express the rate of a multistep electrochemical reaction as a function of measurable parameters, for a given reaction mechanism.
Prerequisites	There are no prerequisite courses. However, the students should have basic knowledge of Physical Chemistry, with focus on Chemical Thermodynamics and Chemical Kinetics.
Course contents	*Introduction to electrochemistry:* The subject of electrochemistry. Electrochemical vs. purely chemical reactions. Electrochemical cells. *Ions and electrolytes*: Activities of ions in electrolyte solutions - Activity coefficients. Interactions among ions in electrolyte solutions - Debye-Hückel theory. Electrical conduction in electrolyte solutions (mechanisms of ion transfer, ionic mobility, transport numbers, conductivity of electrolyte solutions and relevant calculations). Electrolyte melts. Solid electrolytes. *Electrode/electrolyte interphases and electrochemical cells:* The structure of the electrified interphase. The potential of phases. Potential difference across an electrode/electrolyte interphase and components of the measured potential in an electrochemical cell. Polarizable and non-polarizable interphases. Reference electrodes. The normal hydrogen electrode and the electrochemical series. The IUPAC conventions for electrochemical cells and for the sign of electromotive force. Spontaneous and non-spontaneous reactions in electrochemical cells. Prediction of the spontaneous direction of redox reactions using electrode potential data. *Thermodynamics of electrochemical reactions*: Basic concepts. Electrochemical potential and electrochemical Gibbs free energy. Electrochemical equilibrium. The Nernst equation. *Electrode kinetics*: The relation of current density to electrochemical reaction rate. Exchange current density. Faraday's laws of electrolysis. Effect of potential on activation energy and rate of an electrochemical reaction. The meaning and types of overpotential. Activation overpotential. The Butler-Volmer equation. The Tafel equation. Mass transport limitations in electrochemical systems. Concentration overpotential and limiting current density. Ohmic overpotential. Measurement of electrode overpotentials. Operating potential of an electrochemical cell. Development of kinetic models for multistep electrochemical reactions. *Electrocatalysis and Electrochemical Promotion of Catalysis (EPOC):* Basic concepts and application examples.

Suggested reading	1. E. Gileadi, "Electrode Kinetics for Chemists, Chemical Engineers, and Materials Scientists", VCH, New York, 1993 2. J. O' M. Bockris and A. K. N. Reddy, "Modern electrochemistry", Vol.1 (Ionics), 2nd Edition, Kluwer Academic/Plenum Publishers, New York, 1998 3. J. O'M. Bockris, A. K. N. Reddy and M. Gamboa-Aldeco, "Modern electrochemistry", Vol.2 (Fundamentals of Electrodics), 2nd Edition, Kluwer Academic/Plenum Publishers, New York, 2000 4. D. Pletcher, "A First Course in Electrode Processes", The Electrochemical Consultancy, Romsey, England, 1991
Teaching and learning methods	Lectures using slides (MS Power Point) combined with standard class teaching, mainly for solving of problems to consolidate the theoretical knowledge. Homework exercises Besides the textbook of choice (among those recommended by the lecturer), the students are provided with notes, with the slides of the lectures (in electronic form) as well as with additional educational material, such as publications in scientific journals. They are also guided in literature search and in retrieving relevant information from the Internet.
Assessment and grading methods	1. Final written exam 2. Mid-term written exam (on volunteer basis). The mid-term exam grade is taken into account only if it is higher than that of the final exam. 3. Homework exercises (usually four sets), on volunteer basis. The written exams comprise both theoretical questions (part of them in the form of multiple-choice questions) and solving of simple exercises.
Language of instruction	Greek
Course URL	https://eclass.upatras.gr/courses/CMNG2149/

Reactor Analysis and Design

Course title	**Reactor Analysis and Design**
Course code	**CHM_E40**
Type of course	Elective
Level of course	Undergraduate
Year of study	4th
Semester	8th
ECTS credits	4
Name of the lecturer	X. E. Verykios

Learning outcome	At the end of the course the student should: 1. Have a good understanding of the operation of basic heterogeneous chemical reactors. 2. Be familiar with the models which have been proposed for the simulation of catalytic reactors and their basic principles. 3. Know in depth the basic pseudo-homogeneous model for fixed bed reactors
Competences/Skills	At the end of the course the student will have developed further the following skills: 1. Ability to apply numerical methods for the solution of differential equations. 2. Ability to understand basic principles of analysis and design of heterogeneous catalytic reactors. 3. Ability to design fixed bed reactors with simple pseudo-homogeneous models.
Prerequisites	Chemical Reaction Engineering I and II
Course contents	Algorithms for the numerical solution of differential equations Mass, energy and momentum balances applied to chemical reactors. Pseudo-homogeneous models of heterogeneous reactors. Isothermal and adiabatic reactors Polytropic reactors.
Suggested reading	X. E. Verykios "Heterogeneous Catalytic Reactions and Reactors", Costarakis Press, Athens, in Greek. J. M. Smith, "Chemical Engineering Kinetics", McGraw-Hill, New York 1981. G. F. Froment and K. B. Bischoff, " Chemical Reactor Analysis and Design", John Wiley, New York 1979
Teaching and learning methods	Lectures and solution of problems
Assessment and grading methods	Solution of problems all through the semester. Final examination
Language of instruction	Greek
Course URL	

Transport Phenomena Simulation

Course title	**Transport Phenomena Simulation**
Course code	**CHM_E69**
Type of course	Elective
Level of course	Undergraduate
Year of study	5th
Semester	10th

ECTS credits	4
Name of lecturer	Yannis Dimakopoulos
Learning outcome	In the end of the course, the student should understand: • The basics of computational transport phenomena. • How to discretize 3d spaces and construct high quality meshes • How to solve realistic problems • Develop a student's ability for result presentations and data visualization of engineering problems.
Competences/Skills	The student will have developed the following skills: • Be able to simplify complex flow phenomena to simpler ones and solve them. • Develop and simplify mass and momentum balances, determine the relevant auxiliary conditions and solve the resulting equations. • formulate mathematically advanced models for transport of momentum, heat and mass. • analyse engineering flow problems using theory and computational means. • analyse engineering mass transport problems using theory and computational means.
Prerequisites	Prerequisite courses have not been set. The students however, must have good knowledge of Fluid Mechanics, Heat & Mass Transfer, Numerical Methods.
Course contents	• **Introduction to Finte Volume, Finite Element, and Finite Difference Methods** • **Mesh Generation** Unstructured vs structured mesh, assessment of mesh quality, effect of element shape on accuracy and stability, false diffusion due to mesh alignment, types of boundary conditions, computational assignment using CAE tool. • **Momentum Transport in Laminar Flows** Introduction to Navier-Stokes (NS) equations in dimensional and non-dimensional form, special cases of creeping and inviscid flows, iterative and non-iterative methods for numerical solution of NS equations (SIMPLE, PISO, FSM methods), computational assignment using CAE tool. • **Heat Conduction and Convection in Laminar Flows** Steady and unsteady heat condition equations, natural and forced convection in laminar flows, introduction to relevant non-dimensional numbers, difficulties faced in numerical solution of energy equation, coupling of energy and momentum equations, computational assignment using CAE tool. • **Mass Transport in Laminar Flows**

	Fick's law of mass diffusion, equations of change for multi-component gas-phase diffusive and convective mass transport, introduction to relevant non-dimensional numbers, solution procedure for mass transport equation, computational assignment using CAE tool • **Introduction to Turbulent Flows** Practical examples of turbulent flows, statistical description of turbulent flows, scales of turbulent motion, transition from laminar to turbulent flows, examples of free shear flows and wall flows • **Introduction to Simulations of Turbulent Flows** Turbulence modelling approaches (RANS, LES, DNS), choice of an approach based on computational cost and relevant physics, examples of most commonly used turbulence models, computational assignments using CAE tool • **Introduction to OpenFoam** • **Applications with OpenFoam**
Suggested reading	**Text Book:** H. K. Versteeg and W. Malalasekera, 'An Introduction to Computational Fluid Dynamics: the Finite Volume Method', Longman Scientific & Technical, 2007. **Books for additional studying** • J. H. Ferziger and M. Peric, 'Computational Methods for Fluid Dynamics', Springer, 2004. • C. Hirsch, 'Numerical Computation of Internal and External Flows: Volume 1, Fundamentals of Numerical Discretization', 2nd Edition, John Wiley & Sons, 2001. • C. Hirsch, 'Numerical Computation of Internal and External Flows: Volume 2, Methods of Inviscid and Viscous Flows', John Wiley & Sons, 2001.
Teaching and learning methods	• Lectures are presented via PowerPoint, while the related problems are solved on the board. Slides are given to students in digital format. • Six (6) sets of exercises are given during the semester. The students are asked to solve them within a week's time during which they can ask for clarifications.
Assessment and grading methods	The course grade is determined by the exercises (45%), and a research project (55%) based on the recent scientific literature.
Language of instruction	Greek

Special Topics in Physical Chemistry

Course title	**Special Topics in Physical Chemistry**
Course code	**CHM_E30**

Type of course	Elective
Level of course	Undergraduate
Year of study	5th
Semester	10th
ECTS credits	4
Name of the lecturer	Vlasis Mavrantzas
Learning outcome	At the end of this course the student is expected to have obtained a working understanding of the connection between macroscopic sciences and microscopic descriptions of matter through a combination of theoretical models and principles of thermodynamics. For a chemical engineer emphasizing such a connection is particularly important because it allows the prediction of the values of certain properties and processes for the system under study from the knowledge of a few literature data for the underlying molecular interactions in the system. The student is also expected to have obtained a deep understanding of several phenomenological or molecular theories. Typical examples include the use of principles from the kinetic theory of gases or the molecular theory of Einstein for diffusion, the use of dynamic light scattering for the prediction of diffusion coefficient, etc.
Competences/Skills	At the end of the course, the student will be able to: 1. To develop Brownian Dynamics algorithms in order to simulate diffusive phenomena and compute fluxes and transport rates 2. To make use of the entropy balance as an additional tool for understanding and modeling processes taking place in the system under nonequilibrium conditions 3. To build a fundamental understanding of the method of dynamic light scattering and its application in the experimental and theoretical study of hydrodynamic fluctuations and hydrodynamic interactions 4. To develop a strong background on the thermodynamics of interfacial systems and the corresponding balance equations under flow conditions 5. To be able to use Boltzmann's fundamental kinetic theory of gases in processes taking place in the gas phase in order to compute transport properties and collision rates for the determination of quantities such as rates of chemical reactions, the Brownian agglomeration of particles, the growth of thin films on substrates from the gas phase, etc.
Prerequisites	Very good knowledge of Thermodynamics, Physical Chemistry, and Transport Phenomena
Course contents	1. The diffusion equation: A partial differential equation. Probability flux, drift and diffusion. Some exact solutions

	in terms of Gaussians. Equilibrium probabilities. Eigenfunction methods. Increasing dimensionality. 2. Brownian dynamics: Stochastic difference equations. Stochastic differential equations. Itô versus Stratonovich. Boundary conditions. Single particle diffusion in one dimension. 3. Forces and Fluxes: Local thermodynamic equilibrium. Entropy balance. Cross effects. Thermoelectric effects. 4. Dynamic light scattering: Fluctuations and correlation functions. Light scattering basics. Hydrodynamic fluctuations. Dynamic structure factor. 5. Kinetic theory of gases: Model of a rarefied gas. Mean free path and transport coefficients. Boltzmann's equation. Differential cross section for collisions. Chapman-Enskog expansion. 6. Thermodynamics of interfaces: Multiphase systems. Where exactly is the interface? Fundamental thermodynamic equations. Local equilibrium. Curved interfaces. 7. Interfacial balance equations: Dividing surfaces and normal velocities. The interface velocity and jump balances. Time evolution of excess densities. 8. Interfacial force-flux relations: Entropy evolution equation. Consequences of local equilibrium. Constitutive equations. Constitutive equations for mixtures. Evolution equations for temperature and chemical potentials.
Suggested reading	1. D.C. Venerus and H.C. Öttinger, A Modern Course in Transport Phenomena (2015). 2. P.W. Atkins, Physical Chemistry, 5th Ed., Oxford Univ. Press, Oxford (1994).
Teaching and learning methods	The instructor prefers teaching by writing a lot on the blackboard
Assessment and grading methods	Weekly homework sets, final exam
Instruction language	Greek
Course URL	

Physicochemical Properties of Materials

Course title	**Physicochemical Properties of Materials**
Course code	**CHM_E20**
Type of course	Elective
Level of course	Undergraduate
Year of study	5th
Semester	10th
ECTS credits	4

Name of the lecturer	S. Kennou
Learning outcome	Understanding in depth of the physicochemical properties of solids
Competences/Skills	Understanding of material properties in atomic scale by the use of simple model.
Prerequisites	Knowledge of Material Science
Course contents	**Chemical bonding in solids**: Covalent, ionic, metallic, hydrogen and van der Waals bonds. **Crystal structures**: Lattice, point symmetry, the 32 crystal lattices, simple crystal structures. **Diffraction from periodic structures**: Diffraction principles. Reciprocal lattice, diffraction conditions and periodic structure. Bragg's law. Brillouin bands, structure analysis methods. **Dynamics of atoms in the crystals**: Potential, Equation of motion. Diatomic linear chain. **Thermal properties**: Crystal lattice specific heat capacity, thermal relaxation **Free electrons in solids**: Free electrons gas. Specific heat of electrons in metals. Thermionic emission of electrons in metals. **Electronic band structure in solids**: Examples in different types of solids. Density of states. **Magnetic properties**: Diamagnetism. Paramagnetism. Ferromagnetism. Anti-ferromagnetism. **Dielectric properties of materials**: Dielectric function, absorption of electromagnetic radiation. **Semiconductors**: Intrinsic semiconductors, Doping, Carrier density, conductivity, p-n junction.
Suggested reading	C.Kittel, "Introduction to solid state physics", 7th Ed., J.Wiley, 1995 H. Ibach - H. Lueth , "Solid State Physics – Introduction to the principles of Materials Science", Springer-Verlag, 2009
Teaching and learning methods	Lectures using electronic and conventional means. Analytic presentation of selected example and problems solutions.
Assessment and grading methods	Homework given every week and final written exam with questions/problems (50% +50%)
Language of instruction	Greek
Course URL	https://eclass.upatras.gr/

Surface Science

Course title	**Surface Science**
Course code	**CHM_E30**
Type of course	Elective

Level of course	Undergraduate
Year of study	5th
Semester	10th
ECTS credits	4
Name of the lecturer	S. Ladas
Learning outcome	**1.** Understanding the concept of a solid surface (and of the interface between two solid phases) , as a region of the solid which is a natural extension of its bulk, but with modified properties, special characterization requirements and distinct applications. **2.** Introductory exposure of the students in the principles of ultra high vacuum (UHV) technology, which is indispensable in the experimental study of solid surfaces and thin films. **3.** Familiarization of the students with the basic characteristics of crystalline surfaces (chemical composition, structure, electrical properties, dynamic properties, chemical reactivity), the main experimental techniques for their property study and the respective technological applications in diverse areas, both in Chemical Industry (adsorption, heterogeneous catalysis) and in Material Science and Engineering (electronic materials, coatings) .
Competences/Skills	At the end of the course the student will have further developed the following skills/competences: **1.** Competence to perceive the basic operational principles of ultra high vacuum installations and to describe the pumping process under molecular flow conditions. **2.** Skill to describe single crystal solid surfaces at the atomic level and to recognize the basic features of symmetry and arrangement of structural units in relation to the underlying three-dimensional solid. **3**. Competence to recognize the great variety of specialized experimental techniques necessary for studying the behavior of surfaces in relation to their possible applications.
Prerequisites	There are no formal prerequisites. Students are expected to have basic knowledge from Physical Chemistry I&II, Material Science I&II, as well as Instrumental Analysis courses.
Course contents	Clean solid surfaces and interfaces- An Introduction. The necessity of ultra high vacuum in the study of atomically clean surfaces - Introduction to ultra high vacuum technology. Methods of surface analysis. Introduction to the main spectroscopic techniques for solid surface chemical characterization. Atomic surface structure. Elements of 2-D crystallography. Structure determination using electron diffraction techniques and scanning probe microscopies.

	Electronic properties of solid surfaces. The Work Function and its measurement. Metal-semiconductor interfaces. Surface atomic motion. Diffusion. Surface melting. Adsorption processes on solid surfaces. Preparation and characterization of thin solid films – epitaxy. Applications in microelectronics.
Suggested reading	1. S. Kennou, S. Ladas, Surface Science Notes, Patras, 2012 (in Greek). 2. M. Prutton, "Introduction to Surface Physics", Oxford Science Publications, Clarenton Press, Oxford, 1994. 3. WEB-based Courses : http://www.uksaf.org
Teaching and learning methods	Lectures with parallel simple problem solving to assimilate the concepts taught. Guidance of the students in searching for internetic information related to the description and characterization of surfaces. Demonstration of relevant experimental techniques available at Surface Science Laboratory, a departmental research lab.
Assessment and grading methods	Final written examination, involving test questions and simple problems related to the understanding of the course content, with open books and student notes (100% of final grade).
Instruction language	Greek or English
Course URL	https://eclass.upatras.gr/

Environmental Technology: Solid Waste Treatment

Course title	**Environmental Technology: Solid Waste Treatment**
Course code	**CHM_E52**
Type of course	Elective
Level of course	Undergraduate
Year of study	5th
Semester	10th
ECTS credits	4
Name of the lecturer	Michael E Kornaros
Learning outcome	After completing this course a student should be able to: i) understand the characterization of solid wastes in terms of contained materials (qualitative and quantitative). ii) have a greater fundamental understanding of the systems for temporary storage, collection and transportation of municipal solid wastes iii) understand and select the most appropriate physical processes for designing a material recovery facility iv) understand, select and design the fundamental mechanical, thermal and biological processes for the management of solid wastes

	v) understand the fundamental principles for the design, construction and operation of a municipal landfill
Competences/Skills	At the end of the course the student will have further developed the following skills/competences: i) ability to identify and measure the qualitative and quantitative characteristics of solid wastes ii) ability to design a collection system for municipal solid wastes and optimizing the routes for cost minimization iii) ability to select, analyze and design the most appropriate mechanical, thermal and biological processes for the management of solid wastes iv) ability to design and operate a municipal landfill
Prerequisites	There are no prerequisites for this course. However, students should have basic knowledge of mass and energy balances and unit operations.
Course contents	Qualitative and quantitative characteristics of solid wastes. Integrated solid waste management. Special wastes. Source sorting and recycling. Design of solid waste collection systems. Mechanical separation into fractions. Landfill design, operation and closure. Thermal conversion processes (incineration, pyrolysis, gasification). Biological conversion processes (composting, anaerobic digestion). Economic and environmental assessment of alternative integrated solid management scenarios. **Keywords:** solid wastes, recycling, mechanical separation, incineration, pyrolysis, gasification, composting, landfilling
Suggested reading	1. "Sustainable management of municipal solid wastes", D. Panagiotakopoulos, Zygos Publishing, 2002, Thessaloniki. ISBN: 960-8065-31-3 (in Greek). 2. "Handbook of Solid Waste Management", 2nd Edition, G. Tchobanoglous, F. Kreith. Translation in Greek: A. Kougkolos,, A. Karagiannidis, P. Samaras, Tziolas Publishing, 2006, Thessaloniki. ISBN 978-960-418-247-3
Teaching and learning methods	Lectures, solving of exercises and problems from past exams, technical visit to a local material recovery facility and municipal landfill.
Assessment and grading methods	Written examination (100% of the final mark)
Language of instruction	Greek
Course URL	https://eclass.upatras.gr/

Environmental Technology: Industrial Wastewater Treatment

Course title	**Environmental Technology: Industrial Wastewater Treatment**

Course code	**CHM_E91**
Type of course	Elective
Level of course	Undergraduate
Year of study	5th
Semester	10th
ECTS credits	4
Name of the lecturer	Dionissios Mantzavinos
Learning outcome	The course offers specialized knowledge in the field of industrial wastewater treatment by means of separation methods (such as membranes, adsorption, precipitation), as well as the so-called advanced oxidation processes (AOPs). Emphasis is given on the application of the aforementioned technologies to environmental protection issues.
Competences/Skills	At the end of this course the student will have developed skills regarding: 1. Major sources of industrial pollution, characteristics and assessment of polluting loading. 2. Design and application of separation processes for the treatment/valorization of effluents. 3. Fundamentals and design of AOPs.
Prerequisites	Environmental Technology: Wastewater Treatment (XME92).
Course contents	Sources and characteristics of industrial effluents Methods of evaluation of the polluting loading Physical and chemical treatment technologies • Chemical precipitation • Adsorption • Membranes Advanced oxidation processes (AOPs) • Ozone oxidation • Photocatalysis • Electrochemical processes • Ultrasound irradiation • Thermochemical processes Process integration Effluent valorization and recovery of valuable products Case studies • Agro-industrial effluents • Heavy metals • Textile effluents
Suggested reading	1. "Advanced Oxidation Processes for Water & Wastewater Treatment", Ed. S.A. Parsons, IWA Publishing, 2004 2. "Wastewater Engineering: Treatment & Reuse", Metcalf & Eddy, 4th edition, McGraw-Hill

	3. "Wastewater Management", Lyberatos & Vayenas, Tziolas Publications (in Greek)
Teaching and learning methods	Lectures, tutorials.
Assessment and grading methods	Final exam, assignment.
Language of instruction	Greek

Soft (Renewable) Energy Sources

Course title	**Soft (Renewable) Energy Sources**
Course code	**CHM_E55**
Type of course	Elective
Level of course	Undergraduate
Year of study	5^{th}
Semester	10^{th}
ECTS credits	4
Name of the lecturer	Eleftherios Amanatides
Learning outcome	At the end of this course the student should learn: A. The basic types of renewable energy sources and the main technologies for their utilization B. The basics of solar engineering and wind potential/wind properties C. The way of photovoltaic (pv) modules operation, the different pv technologies and their basic properties. D. The way of wind turbines operation, the different types of wind turbines and their main properties E. The distinguish between passive and energetic thermal solar systems and their main applications in heating/cooling and electricity production F. The main types of geothermal energy and their application in heating/cooling and electricity production. G. The basic types and utilization methods of biomass
Competences/Skills	At the end of the course the student will have further developed the following skills/competences: A. Ability to calculate the solar and wind potential in a specific latitude – longitude B. Ability of designing and dimensioning the operation of a pv plant and calculation of cost and energy production C. Ability of designing and dimensioning the operation of a wind plant and calculation of cost and energy production D. Ability to choose proper equipment and process for energy production from biomass

	E. Ability to calculate the efficiency of thermal solar systems and the energy saving in heating/cooling applications
Prerequisites	There are no prerequisite courses. It is, however, recommended that students should have knowledge of basic energy balances and techno-economical analysis
Course contents	A. Introduction to Renewable Energy Systems and utilization technologies. Current status in Greece, Europe and worldwide. B. Solar Engineering and solar energy. Basic equations for calculation of incident solar power on horizontal and incline level C. Photovoltaics for electricity production. Semiconductors, Photovoltaic cells and modules. Different PV technologies. Design of PV plants and technoeconomical analysis. D. Passive and energetic thermal solar systems for electricity production and heating/cooling applications. From solar collectors to solar towers. E. Wind power and basic wind properties. Production of mechanical and electrical energy from wind turbines. Main types of wind turbines. Design of wind plants and technoeconomical analysis. F. Geothermal energy and technologies for utilization of low and high enthalpy geothermal fields. G. Systems for production, storing and utilization of biomass products H. Small hydroelectric plants: Methods of energy production and environmental costs
Suggested reading	1. Soft Energy Sources I – Environment and Renewable Energy Systems 1st edition, Author: Kaplanis S. ISBN: 978-960-411-429-0 2. Renewable energy [electronic resource], 3rd edition, Authors: Sorensen, Bent, ISBN: 0126561532
Teaching and learning methods	1. Classes in PowerPoint that are uploaded for the students in the e-class site of the course 2. The instructor solve exercises during the classes
Assessment and grading methods	1. One project per group of one or two students in a specific Renewable Energy Systems topic (50 % of final grade). The students presents their project and deliver a 10 pages summary of the project 2. Final written exams (50 % of final grade)
Instruction language	Greek
Course URL	https://eclass.upatras.gr/courses/CMNG2115/

Biomechanics II

Course title	**Biomechanics II**

Course code	**CHM_E58**
Type of course	Elective
Level of course	Undergraduate
Year of study	5th
Semester	10th
ECTS credits	4
Names of lecturers	G. Athanassiou, D. Deligianni (Department of Mechanical Engineering & Aeronautics)
Learning outcomes	The aims of the course for the student are to: • Understand and quantify biochemical and electrical phenomena which are responsible to produce musculoskeletal work. • Understand the phenomena that create the stimulus for the muscle contraction. • Understand the forces and stresses that are applied or developed on parts of the human body, and the outcomes of these loads in a 3-dimensional frame. • Gain an understanding of the mechanical and anatomical principles that govern human motion and develop the ability to link the structure of the human body with its function from a mechanical perspective.
Competences	At the completion of this course it is desired that each student be able to apply the laws and principles of engineering in the study of biological systems and quantify the forces and relationships that were described in the former paragraph.
Prerequisites	There are no prerequisite courses. The students should have a basic knowledge of Mechanics of Deformable Solids and Strength of Materials.
Course contents (analytic description & key-words, basic terns)	Introduction in the relationship between the neuromuscular system and the response of the human musculoskeletal system. Neuromuscular human system. Neuron. The current and the conductivity functions of Na and K ions into the neuromuscular system. Rest potential and action potential. Neuromuscular unit. Correlation of biochemical and/or bioelectrical functions of neuromuscular system with muscle contraction and forces producing. Electromyography. Methodologies to musculoskeletal fatigue estimation. Musculoskeletal system – cartilage, tendons, ligaments: Basic anatomy and physiology, Mechanical functions, Physiological functions, Composition, Microscopic- macroscopic structure, Tissue mechanical characteristics, correlation with structure. 3-D musculoskeletal system modeling.

	Keywords: Neuromuscular system; Musculoskeletal system; Mechanical behavior; Modeling, Structure-function of biological systems
Recommended reading	Lecture notes and handouts, accessible via the Open eClass (Asynchronous Teleteaching Platform) of the University of Patras, and relevant Internet links.
Teaching and learning methods	Lectures using slides (MS PowerPoint) combined with standard class teaching, mainly for solving of problems to consolidate the theoretical knowledge. Final project involving, among others, literature search. Besides Notes, the students are provided with the slides of the lectures (in electronic form) as well as with additional educational material, such as publications in scientific journals. They are also guided in literature search and in retrieving relevant information from the Internet.
Assessment and grading methods	Final written exam. Presentation of the project (on volunteer basis).
Language of instruction	Greek
Course URL	https://eclass.upatras.gr/courses/MECH1197/

Suspensions and Emulsions

Course title	**Suspensions and Emulsions**
Course code	**CHM_E61**
Type of course	Elective
Level of course	Undergraduate
Year of study	5th
Semester	10th
ECTS credits	4
Name of the lecturer	P. Koutsoukos
Learning outcome	1. Definitions on suspensions and emulsions : The colloidal state. Understanding of the importance of the interface in dispersed systems. 2. Deviation from ideal behavior due to electrostatic interactions. From ions to particles. 3. Mechanism of development of electric charge on suspended particles and emulsions. 4. Measurements of surface potential of suspended particles. Important parameters for meaningful measurements. 5. Characteristics of films and foams

	6. Understanding factors responsible for the stability of suspensions and emulsions.
Competences/Skills	• Familiarization with the class of materials known as dispersed systems • Understanding of the factors responsible for the stability of suspensions and emulsions. • Ability of choice of the most suitable approach to control the stability of a suspension, emulsion and /or film. • Familiarization with the experimental methods for the measurement of parameters which determine the stability of specific types of suspensions or emulsions.
Prerequisites	There are no formal prerequisites. Physical Chemistry knowledge is strongly recommended.
Course contents	Dispersed matter. Liposomes and emulsions. The solid-liquid interface. DEBYE-HUCKEL theory for electrolytes. Extension to charged interfaces. The electrical double layer. Negative adsorption, Donnan equilibria and ion exchange. The point of zero charge. Thermodynamic analysis of the electrical double layer. The electrocapillary curve (Lippmann equation). Experimental measurements of the electro capillary curves and their significance for the electrical double layer parameters. Specific adsorption. Potentiometric titrations. Surface and ζ potential. Electrokinetic phenomena. Films and foams and their respective stability. The role of surfactants and drain. Repulsion between approaching double layers. Stability of lyophobic colloids. The DLVO theory. The Schultze-Hardy rule. The interaction between two particles. The Hamaker coefficient. The aggregation concentration
Suggested reading	• C.Panagiotou, Interfacial Phenomena & Colloid Systems (In Greek) , Zitis Publ. Thessaloniki, 1998 • P.Koutsoukos, Colloid Chemistry (In Greek), University of Patras, 1996. • P.C.Hiemenz, R.Rajagopalan, Principles of Colloid and Surface Chemistry, 3rd Ed. CRC Press, 1997 • D.J.Shaw, Introduction to Colloid and Surface Chemistry, 4th ed., Butterworth-Heinemann, Oxford 1992
Teaching and learning methods	Lectures using electronic and conventional means. Analytic presentation of selected examples. Student guidance to seek internet and other course related Literature information.
Assessment and grading methods	Homework assignments during the course for better understanding lecture material. Final assessment from the final, written exam.
Language of instruction	Greek
Course URL	https://eclass.upatras.gr/

Metallurgy

Course title	**Metallurgy**
Course code	**CHM_E80**
Type of course	Elective
Level of course	Undergraduate
Year of study	5th
Semester	10th
ECTS credits	4
Name of the lecturer	George N. Angelopoulos
Learning outcome	After completing this course a student should be able to: - apply physical and chemical methods to extract metals, especially iron and aluminium, from their ores - work out temperature adjustments, raw material mixtures and other processing variables to make metals - conduct studies of metals and alloys before and during processing to determine their properties - supervise sampling from various stages of processing for laboratory analysis and testing - examine metal processing techniques to make sure that quality is maintained and to improve processing or develop new methods - investigate whether methods being used are economical, efficient and environmentally acceptable
Competences/Skills	At the end of the course the student will have further developed the following skills/competences: - to prepare technical reports - to contribute and adhere to safety requirements - be able to identify, analyze and solve problems - be able to communicate well orally, in writing and graphically - be practical and creative - be able to work without supervision - be able to accept responsibility
Prerequisites	The student should have Mathematical skills and knowledge of Chemical Thermodynamics and Physicochemistry.
Course contents	History of Metallurgy. The metals in Greek Mythology. Production of iron and steel. Iron. From iron ore to steel. Reduction of metal. Ores, coke, blast furnace. Reduction reactions. Ellingham diagrams. Boudouard and Chaudron diagrams. Mass balances in the blast furnace. Cast iron. Pretreatment of iron. Steel making. Refining processes. Refining reactions. Oxygen processes. Electric arc furnace. Qualities and classification of steels. Aluminum production. Production of alumina from bauxite method Bayer. Electrolysis

	of alumina. Hall-Héroult process. Qualities and alloys of aluminium. **Keywords**: Extractive Metallurgy. Metals. Iron. Aluminum. Slags.
Suggested reading	Instructor notes
Teaching and learning methods	Courses, projects or assignments
Assessment and grading methods	1. Project or assignment that includes technical writing and oral presentation. 2. Written examination
Language of instruction	Greek
Course URL	http://www.chemeng.upatras.gr/en/content/courses/en/metallurgy