2020-2021

DEPARTMENTAL CURRICULUM

UNIVERSITY OF PATRAS

Department Of Chemical Engineering

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BACK TO TOC

ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΑΤΡΩΝ
UNIVERSITY OF PATRAS

ChemEngUP

SCHOOL OF ENGINEERING

DEPARTMENT OF CHEMICAL ENGINEERING

DEPARTMENTAL CURRICULUM of Undergraduate Studies

2020 - 2021

CARE OF PRESENTATION: S. Bebelis, Professor

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1. THE DEPARTMENT OF CHEMICAL ENGINEERING

1.1 Introduction

The Department of Chemical Engineering of the School of Engineering of the University of Patras (ChemEngUP) was established in 1977. It 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.

ChemEngUP produces chemical engineers educated in research, development and optimization of methods for the production of industrial products, in materials technology, in energy production and in environmental protection.

ChemEngUP 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 ChemEngUP 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 ChemEngUP are qualified and experienced, with many of them awarded by international and national scientific associations and/or acting as editors of international scientific journals. They are also involved in important research projects funded by European competitive programs, the Greek General Secretariat for Research and Technology (GSRT), other Greek organizations and industry, in collaboration with some of the top universities and research centers globally. The faculty comprises twenty full professors, four associate professors, four assistant professors and two lecturers. They all hold PhD degrees and are active researchers while twenty-one of them are chemical engineers (70%), one is a mechanical engineer, six are chemists and two physisists.

Additional information about the people, the studies and research in ChemEngUP can be found at the Department website (http://www.chemeng.upatras.gr/en/).

1.2 Mission

The mission of ChemEngUP is twofold:

1. To advance knowledge in the field of chemical engineering science, and
2. to educate students in chemical engineering and chemical technology from undergraduate to advanced postgraduate level.

ChemEngUP aims at promoting excellence at the national and international levels. We are committed to the application of the principles of meritocracy and ethos within the framework of academic teaching and research, aiming in the strengthening of students' scholarly attitude and love of learning.

Specific targets of the Department are as follows:

- to provide our students with a strong background in mathematics, physical sciences and chemical engineering science, as well as train them in engineering design through education and practical experience involving data collection, critical evaluation, analysis and synthesis;
- to instil to our graduates the idea of life-long learning and continuing professional development, both much needed in a technologically changing society within a globalized economy;
- to prepare the next generation professionals and leaders that will be capable of following the rapidly evolving scientific developments and using modern tools and methodologies based on research and learning;
- to create new knowledge and advance existing one through fundamental and applied research in chemical engineering and beyond, thus promoting multi- and inter-disciplinary research strategies;
- to contribute to the development and economic growth of the region and the country as a whole, in collaboration with local organizations and enterprises and within the frame of research excellence and innovation.

1.3 Professional Ethics and Integrity Policy

ChemEngUP is committed to uphold the ethical standards resulting from the implementation of pertinent laws, rules and regulations relating to higher education and research in Greece, and relevant decisions of the governing bodies of the University of Patras. Moreover, ChemEngUP is committed to embrace and adopt best practices that emanate from international experience in an effort to continuously improve its operation.

Specifically, ChemEngUP:

- Perceives as particularly important the obligation to educate its students by emphasizing the principles of integrity, respect for the beliefs and rights of others, promoting health and safety, the welfare of the public and, especially, environmental protection.
- Seeks to disseminate the principles of the "Professional Code of Greek Engineers" of the Technical Chamber of Greece, the "Code of Conduct of European Chartered Engineers" of ECEC, and similar documents from other prestigious international organizations (e.g. FEANI, AIChE), in the context of a more comprehensive preparation of the professional lives of its graduates.
- Gives great importance to the consolidation of ethics and professional integrity in all aspects of the educational process and makes every effort to inform students in all matters relating to breaches of rules of examinations or other means of evaluation.
- Gives particular importance to the recognition of the work of others and therefore educates students on the correct reference procedure. Furthermore, ChemEngUP imposes mandatory use of plagiarism prevention software for all Diploma, Postgraduate Research and Doctoral Theses while it encourages its use for all written work resulting from educational or research projects.
- Seeks to instil in the students the respect of public property and the development of a sense of responsibility for the protection of premises and equipment used in the educational and research process.
- Applies the provisions of the bylaws and the relevant decisions of the governing bodies of the University of Patras in all cases of identified violations of academic rules of conduct applies.
- Has set an Academic Ethics Committee (AEC) consisting of the Chairman, the Deputy Chairman and the Chairman of the Internal Quality Assurance Committee, which investigates complaints about such violations and recommends appropriate actions to the Departmental Assembly. Furthermore, AEC also proposes infringements response procedures, measures to avoid them and amendments to the present Code of Ethics.

Cited Documents:

1. Professional Code of Greek Engineers (in Greek)
2. Code of Conduct of European Chartered Engineers
3. FEANI Position Paper on Code of Conduct: Ethics and Conduct of Professional Engineers
4. AIChE Code of Ethics

1.4 Health and Safety Policy

A. General principles

ChemEngUP is committed, within its capabilities, to take all necessary and practicable measures to protect the Health and Safety of staff, students and any other person working in ChemEngUP or being affected by the activities of the Department.

The Department recognizes that:

- Full compliance with all aspects of legislation relating to health and safety and with the relevant policies and procedures of the University of Patras is necessary[1, 2].
- Effective protection of the health and safety as above, can only be ensured if the necessary financial and human resources are provided.
- The management of health and safety must be one of the main functions and concerns of the entire Departmental management structure.
- All those who are in the Department are responsible for their own personal health and safety and should be attentive to possible dangers. They are also obliged to immediately inform the Health and Safety Committee (HSC) about their nature and location if such dangers arise. Health and Safety assurance is based on both individual vigilance and the implementation of practical procedures and regulations.

B. Scope

The Health and Safety Policy of the Department of Chemical Engineering is applicable to all areas of the Main (K23) and the Extension (K24) Buildings of Chemical Engineers which are located within the campus of the University of Patras, including the outdoor theatre adjacent to those buildings and excluding the Choir Hall 'M. Hadjidakis' which is located in the basement of K23.

C. Responsibilities

- The Chairman of ChemEngUP has overall supervision of Health and Safety within the Department.
- The Chairman of ChemEngUP assigns the day-to-day responsibility of all practical aspects of Health and Safety regarding planning, training and supervision to the HSC.
- The Chairman of HSC assists and advises the Chairman and all other members of the Department on Health and Safety issues. The Chairman of HSC also conducts the investigation of any reported incident , carries out regular safety audits and supervises the compulsory training of students and staff on Health and Safety issues.
- The Chairman of HSC has also the responsibility to communicate, collaborate and report all relevant problems to the Safety Officer of the University of Patras.
- The members of the HSC advise and inform the Chairman of the Committee and the Chairman of the Department about Health and Safety problems and potential risks.

- The Laboratory Directors and Research Supervisors, for non-statutory laboratories, are responsible for safety management of all Researchers supervised by them. The term 'Researchers' includes students, graduate students, postdoctoral researchers, technical staff and visiting scholars.
- The HSC regularly inspects all laboratories and checks for compliance with safety regulations. All problems related to Health and Safety are noted in the Laboratory's Health and Safety Logbook and are brought to the attention of the Research Supervisor and Director of the Laboratory.
- The responsibility for the safety management of activities taking place outside the Department's buildings belongs to the Safety Officer of the University of Patras.
- Faculty members, assistant teaching and technical staff, who are assigned by the Department to teaching courses and laboratory practicals, are accountable for all Health and Safety issues during the teaching of these courses and laboratory practicals.
- Maintaining a safe working environment requires the active participation of all persons in the Department. Everyone has the responsibility to do everything that is reasonably possible to prevent injuries to oneself and others, as well as to prevent damage to the Departmental infrastructure. ChemEngUP requires everyone to know and follow the specific instructions of the current edition of the Department's Health and Safety Manual.
- It is prohibited for any person to deliberately misuse the health and safety equipment located in the Department (eg fire extinguishers, sprinklers, etc.).

D. Training

ChemEngUP is committed to ensuring that:

- All members of staff, administrative and technical employees, students and visitors who are engaged in departmental activities, including experimental research, are provided with adequate training, education and supervision to perform these activities safely.
- The Health and Safety training when recruiting new members of staff (at all levels) and accepting new research staff is mandatory.
- Information related to Health and Safety is communicated to all those mentioned above.

Also, ChemEngUP

- Regularly consults Health and Safety experts and, when necessary, delegates to these certified experts the training of staff and students on special Health and Safety issues.
- Follows recent developments in the field of Health and Safety.

E. Planning and Supervision

- ChemEngUP is committed to working for the continuous improvement of Health and Safety standards in its facilities through the implementation of an integrated management system.
- Considers that Health and Safety are essential elements in the design of curricula and new research programmes.

- Recognizes the need to monitor and regularly discuss in the Departmental Staff Meeting the current performance level of the Health and Safety system and react appropriately.
- Recognizes the need to regularly review policies and procedures to ensure Health and Safety of staff, students and visitors within its premises.

F. Cited Documents:

1. University of Patras Safety Officer website (in Greek)
2. Departmental health and Safety Webpage (in Greek)

1.5 ChemEngUP Personnel

A. Professors and Lecturers

	Name	Rank	Studies	Area
1	E. Amanatides	Assoc. Professor	*Chemist* PhD University of Patras (2001)	Nanostructured Materials
2	G. N. Angelopoulos	Professor	*Mechanical Engineer* PhD University of Patras (1990)	Materials Technology
3	A. Armaou	Professor	*Chemical Engineer* PhD University of California at Los Angeles (2001)	Process control
4	S. Bebelis	Professor	*Chemical Engineer* PhD University of Patras (1989)	Catalysis, Electrochemistry
5	S. Boghosian	Professor	*Chemical Engineer* PhD University of Patras (1990)	Applied Molecular Spectroscopy
6	K. Dassios	Ass. Professor	*Chemical Engineer* PhD University of Patras (2003)	Nanomaterials, Fracture Behaviour of Materials
7	Y. Dimakopoulos	Assoc. Professor	*Chemical Engineer* PhD University of Patras (2003)	Transport Phenomena
8	M. Dimarogona	Ass. Professor	*Chemical Engineer* MRes Universite Paris Descartes (2007) PhD National Technical Univ. of Athens (2012)	Biochemical Engineering
9	C. Galiotis	Professor	*Chemist* PhD Q. Mary University of London (1982)	Composites, Nanomaterials, Nanotechnology
10	A. Katsaounis	Professor	*Chemical Engineer* PhD University of Patras (2004)	Electrochemical Processes
11	S. Kennou	Professor	*Physicist* PhD University of Ioannina (1984)	Surface Physics
12	D. Kondarides	Professor	*Chemist* PhD University of Patras (1994)	Heterogeneous Catalysis and Photocatalysis
13	I. Kookos	Professor	*Chemical Engineer* PhD Imperial College London (2001)	Process Synthesis
14	M. Kornaros	Professor	*Chemical Engineer* PhD University of Patras (1995)	Waste Management
15	D. Kouzoudis	Assoc. Professor	*Physicist* PhD Iowa state University (1998)	Applied Physics
16	G. Kyriakou	Assoc. Professor	*Chemist* PhD University of Cambridge (2004)	Surface Science, Heterogeneous Catalysis
17	D. Mantzavinos	Professor	*Chemical Engineer* PhD Imperial College london (1996)	Wastewater Treatment
18	D. Mataras	Professor	*Chemical Engineer* PhD University of Patras (1990)	Plasma Technology
19	V. Mavrantzas	Professor	*Chemical Engineer* PhD University of Delaware (1994)	Molecular Modelling
20	S. Pandis	Professor	*Chemical Engineer* PhD CalTech (1991)	Air Polution
21	Ch. Paraskeva	Professor	*Chemical Engineer* PhD University of Patras (1992)	Separation Processes
22	G. Pasparakis	Assoc. Professor	*Materials Scientist* PhD University of Nottingham (2008)	Polymers
23	S. Pavlou	Professor	*Chemical Engineer* PhD University of Minnesota (1983)	Biochemical Processes
24	D. Spartinos	Lecturer	*Chemical Engineer* PhD University of Patras (1993)	Chemical Processes
25	I. Tsamopoulos	Professor	*Chemical Engineer* PhD MIT (1985)	Transport Phenomena
26	P. Vafeas	Ass. Professor	*Chemical Engineer* PhD University of Patras (2003)	Applied Mathematics
27	D. Vayenas	Professor	*Chemical Engineer* PhD University of Patras (1995)	Water & Wastewater Treatment

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B. Professors Emeriti

	Name	Studies	Area
1	G. Dassios	*Mathematician* Corresponding Member of the Academy of Athens MSc University of Illinois at Chicago (1972) PhD University of Illinois at Chicago (1975) Habilitation, National Technical Univ. of Athens (1980)	Applied Mathematics
2	P.G. Koutsoukos	*Chemist* MBA, Athens School of Economics (1974) PhD SUNY Buffalo (1980) Habilitation, University of Patras (1984)	Crystal Growth Processes
3	S. Ladas	*Chemical Engineer* PhD Stanford University (1980)	Surface Science
4	P. Lianos	*Physicist* PhD University of Tennesee (1978)	Photochemistry - Photophysics
5	P. Nikolopoulos	*Physicist* PhD T.U. Karlsruhe (1974)	Ceramic and composite materials
6	G. Papatheodorou	MSc in Chemical Physics, Univ. of Chicago (1968) PhD in Physical Chemistry, Univ. of Chicago (1969)	Physical Chemistry - Spectroscopy
7	G. Staikos	*Chemist* DEA, Univ. Paris VI (1984) PhD University of Patras (1986)	Polymers
8	C. Tsitsilianis	*Chemist* PhD University of Patras (1987)	Polymers
9	C. G. Vayenas	*Chemical Engineer* Member of the Academy of Athens Foreign Member, National Academy of Engng., USA PhD Rochester (1976)	Catalysis
10	X. Verykios	*Chemical Engineer* PhD Lehigh (1979)	Catalysis

C. Other Teaching Staff

	Name	Studies	Graduate Studies
1	C. Alexandridou	*Chemical Engineer, University of Patras*	MSc Hellenic Open University
2	E. Alexopoulou	*Mining & Metallurgical Engineer, NTUA*	PhD University of Patras
3	S. Brosda	*Chemist, University of Greifswald*	PhD University of Greifswald
4	U. Kouli	*Chemical Engineer, University of Patras*	
5	S. Sfikas	*Electrical Engineer, University of Patras*	PhD University of Patras
6	D. Sotiropoulou	*Chemical Engineer, University of Patras*	PhD University of Patras
7	M. Tsami	*Chemist*	MSc Université Paul Sabatier, Toulouse

D. Other Technical and Support Staff

	Name	Studies	Graduate Studies
1	E. Mavreli	*Liceum*	
2	Ch. Pilisi	*Liceum*	
3	K. Santas	*Electrical Engineer TE, TEI of Western Greece*	
4	E. Stamatiou	*Liceum*	
5	M. Sypsa	*Business Administration, Hellenic Open Univ.*	
6	M. Theodorakopoulou	*Economics, University of Piraeus*	
7	E. Mavroeidi	*Economics, University of Piraeus*	*MBA University of Patras*
8	K. Fragkoulia	*Liceum*	
9	E. Kottaridi	*Liceum*	
10	Ch. Pilis	*Liceum*	
11	S. Spiliotopoulou	*Liceum*	
12	Th. Polychronopoulos	*Economics, University of Patras*	*MBA University of Patras*

E. Teaching Staff with Appointment

	Name	Studies	Graduate Studies
1	A Christogerou	*Chemical Engineer, University of Patras*	PhD University of Patras (2011)
2	E. Farsari	*Chemical Engineer, University of Patras*	PhD University of Patras (2015)
3	D. Kanelopoulou	*Chemical Engineer, University of Patras*	PhD University of Patras (2012)
4	V. Sygouni	*Chemical Engineer, University of Patras*	MSc, PhD University of Patras (2007)

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2. DIPLOMA IN CHEMICAL ENGINEERING

2.1 General Information

Diploma studies at ChemEngUP last five (5) academic years, divided in ten (10) semesters. Each semester includes thirteen (13) full weeks of lectures. 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; however, the exact academic calendar is defined by the University Senate, and announced three months before the start of each academic year at the University of Patras website.

During each semester a student has to attend a number of compulsory and/or elective modules, including laboratory modules, as specifically described later in this document. Attendance in laboratory modules is mandatory. The total number of European Credit Transfer and Accumulation System (ECTS) units per semester is equal to 30. The total number of ECTS for obtaining a Diploma in Chemical Engineering is equal to 300.

In order to graduate, a student has to pass all the exams associated with 45 compulsory and 10 elective modules, corresponding in total to a minimum number of 242 Teaching Units (TU's). Assignment of a particular number of TU's to each module is determined by the Greek Legislation. Specifically, one (1) TU corresponds to one (1) hour lecture per week per semester, whereas for recitation classes and laboratory work one (1) TU corresponds to two (2) hours per week per semester.

A module is considered successfully passed only when the student has obtained at least a grade of 5 out of 10. This grade is based on the grade obtained in the final written and/or oral exam at the end of each semester, as well as on the grade obtained in intermediate tests and in homework sets or projects, as declared in the module descriptions. A student who fails to pass a module by the end of the corresponding semester has the opportunity of a resit in September of the same year. For laboratory modules, successful completion of a minimum number of laboratory exercises is a prerequisite for passing the module, whereas the final grade is based both on the performance of the student in the lab and in tests preceding each laboratory exercise.

The Design Project (DP) and the Diploma Thesis (DT) are important mandatory parts of the Diploma Studies. The DP is a group project on an open-ended design problem, supervised regularly in the framework of an 8^{th} semester capstone module. On the other hand, DT is an individual research project carried out during semesters 9 and 10 and supervised by a faculty member. DT is presented in public and assessed and graded by an Examination Committee according to a detailet marking scheme. The DT Examination Committee is composed of three members; the supervisor of DT and two permanent members who examine all DT's in a Thematic Area.

Modules are normally offered in Greek. Nevertheless, in addition to personal advising, textbooks written in English are normally recommended by the module instructors to ERASMUS students who have not a good command of the Greek language, so that they are able to attend the modules and pass the exams which can be given in English. A Greek Language Module for foreign students is also offered by the Foreign Language Unit of the University of Patras. Prospective ERASMUS students can contact Assoc. Professor Yannis Dimakopoulos (dimako@chemeng.upatras.gr) for further details.

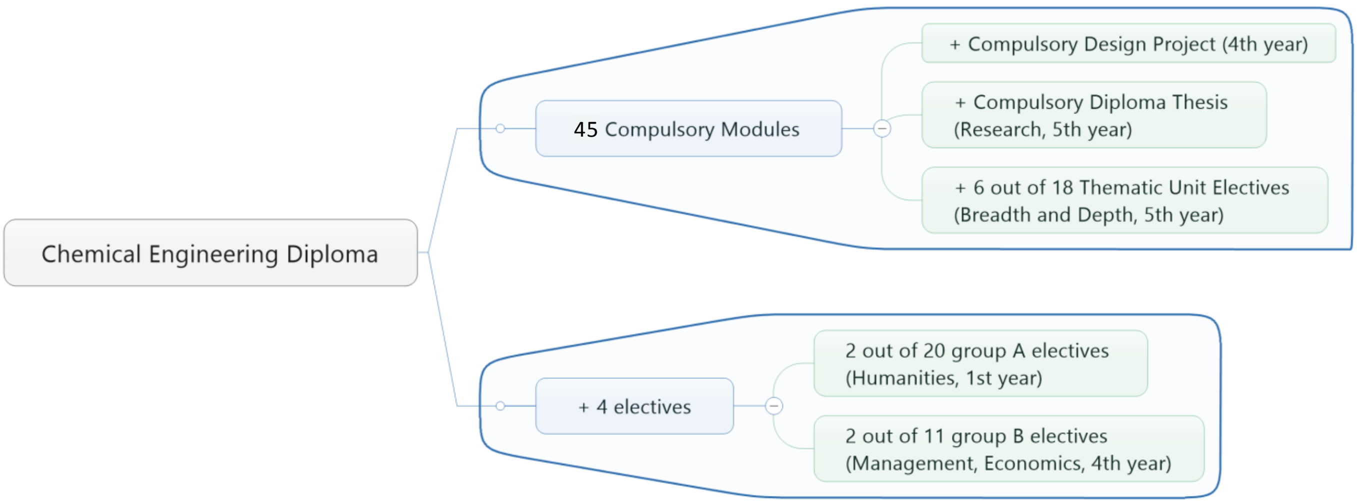
2.2 Teaching Assignment

All compulsory modules, except CHM 312 (English - Technical Terms for Chemical Engineers), and most electives are taught by ChemEngUP Professors and Lecturers. Group A, 1st year electives (humanities) and most of Group B, 4th year electives (management, economics, etc) are taught by staff assigned from the following academic units of the University of Patras:

ACADEMIC UNIT	ABREVIATION	WEBSITE
Department of Mechanical Engineering and Aeronautics	MEAD	www.mead.upatras.gr
Department of Civil Engineering	CIVIL	www.civil.upatras.gr
Department of Physics	DPHYS	www.physics.upatras.gr
Department of Biology	DBIOL	www.biology.upatras.gr
Department of Business Administration	BMA	www.bma.upatras.gr
Department of Economics	DECON	www.econ.upatras.gr
Department of Philosophy	DPHIL	www.philosophy.upatras.gr
Department of Primary Education	ELEMEDU	www.elemedu.upatras.gr
Dept. of Educational Science & Early Childhood Education	ECEDU	www.ecedu.upatras.gr
Foreign Language Unit	FLU	languages.upatras.gr

2.3 Program Structure

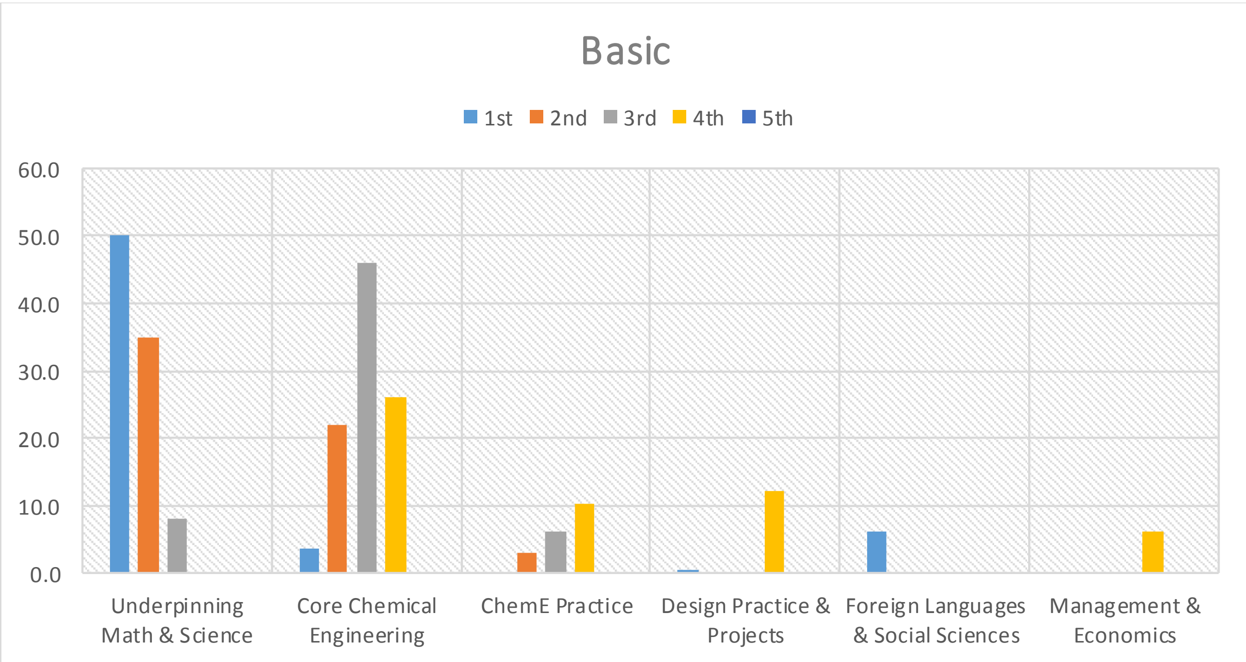
The "*Chemical Engineering Diploma*" programme is composed by 45 compulsory modules, compulsory Design Project and Diploma Thesis (equivalent to 12 modules). This is complemented by 10 electives in three groups. Two electives from group A (humanities), two from group B (management and economics) and six Γ group advanced chemical engineering electives (breadth and depth).

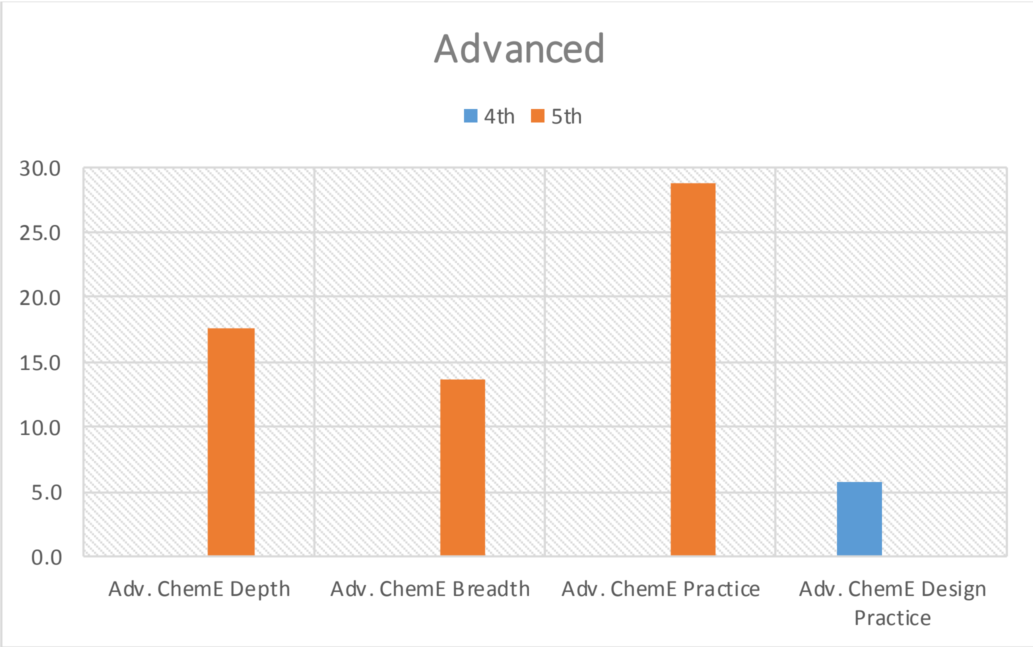


1st to 8th semesters are dedicated to underpinning math and science, core chemical engineering, practice and Design while semesters 8 to 10 focus to advanced chemical engineering subjects and the Diploma Thesis as shown in the following table and graphs.

All the numbers are in European Credit Transfer System Units (ECTS).

subject categories	year of study 1st	2nd	3rd	4th	5th
Basic					
Underpinning Math & Science	50.0	35.0	8.0		
Core Chemical Engineering	3.6	22.0	46.0	26.0	
ChemE Practice		3.0	6.0	10.2	
Design Practice & Projects	0.4			12.0	
Foreign Languages & Social Sciences	6.0				
Management & Economics				6.0	
Advanced					
Adv. ChemE Depth					17.6
Adv. ChemE Breadth					13.6
Adv. ChemE Practice					28.8
Adv. ChemE Design Practice				5.8	
	60.0	**60.0**	**60.0**	**60.0**	**60.0**





The exact composition for each semester is presented in the following paragraphs.

2.4 1st Year – 1st Semester

MN	MODULES	HOURS/WEEK T	R	L	TU	ECTS	INSTRUCTOR
	COMPULSORY MODULES						
CHM_102	Single Variable Calculus and Linear Algebra	4	2	_	5	6	P. Vafeas
CHM_115	Analytical Chemistry	2	1	_	3	4	E. Amanatides
CHM_140	Introduction to Chemical Engineering	3	2*	_	4	4	D. Vayenas - A. Katsaounis
CHM_130	Physics I	3	1	_	4	5	D. Kouzoudis
CHM_110	General and Inorganic Chemistry	3	1	_	4	5	D. Kondarides
CHM_163	Computers Laboratory	1	_	2	2	3	E. Farsari

* 1 hour Seminar , T:Teaching, R:Recitation, L: Laboratory

	ELECTIVES: GROUP A						
CHM_185	History of Technology I	3	_	_	3	3	MEAD
CHM_186	Introduction to Philosophy	3	_	_	3	3	DPHIL
CHM_190	Human Rights	3	_	_	3	3	ECEDU
CHM_190	English	3	_	_	3	3	FLU
CHM_192	French I	3	_	_	3	3	FLU
CHM_193	German I	3	_	_	3	3	FLU
CHM_194	Italian I	3	_	_	3	3	FLU
CHM_195	Russian I	3	_	_	3	3	FLU
CHM_196	Introduction to Environmental Physics	3	_	_	3	3	DPHYS
CHM_197	Introduction to Information and Communication Technologies	3	_	_	3	3	ECEDU
CHM_198	Theory of Democracy: Classical Approaches and Contemporary Problems	3	_	_	3	3	ECEDU

SUM	25	30

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

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2.5 1st Year – 2nd Semester

MN	MODULES	HOURS/WEEK T	R	L	TU	ECTS	INSTRUCTOR
	COMPULSORY MODULES						
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	D. Kanelopoulou
CHM_230	Physics II	3	1	_	4	7	D. Kouzoudis
CHM_232	Physics Laboratory	_	_	4	2	3	S. Kennou - D. Kouzoudis

T:Teaching, R: Recitation, L: Laboratory

	ELECTIVES: GROUP A						
CHM_285	Introduction to Science Education	3	_	_	3	3	ECEDU, Suspended
CHM_191	English	3	_	_	3	3	FLU
CHM_292	French II	3	_	_	3	3	FLU
CHM_293	German II	3	_	_	3	3	FLU
CHM_294	Italian II	3	_	_	3	3	FLU
CHM_295	Russian II	3	_	_	3	3	FLU
CHM_296	Introduction to Educational Sciences	3	_	_	3	3	ELEMEDU
CHM_297	Political Sociology	3	_	_	3	3	ECEDU
CHM_298	History of Technology II	3	_	_	3	3	MEAD

	TU	ECTS
SUM	20	30

2.6 2nd Year – 3rd Semester

MN	MODULES	HOURS/WEEK T	R	L	TU	ECTS	INSTRUCTOR
	COMPULSORY MODULES						
CHM_300	Ordinary Diff. Equations	3	2	_	4	6	S. Pandis
CHM_311	Organic Chemistry Lab.	_	_	4	2	3	C. Tsitsilianis
CHM_220	Thermodynamics I	3	2	_	4	6	S. Boghosian
CHM_363	Computer Programming for Chemical Engineers	4	_	3	5	6	D. Mataras
CHM_421	Physical Chemistry	4	2	_	5	6	D. Kontarides - V. Mavrantzas
CHM_312	English - Technical Terms for Chemical Engineers	3	_	_	3	3	FLU
	SUM				23	30	

2.7 2nd Year – 4th Semester

MN	MODULES	HOURS/WEEK T	R	L	TU	ECTS	INSTRUCTOR
	COMPULSORY MODULES						
CHM_402	Partial Diff. Equations	2	1	_	3	4	P. Vafeas
CHM_521	Physical Chemistry Lab.	_	_	4	2	3	G. Kyriakou - S. Boghosian
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	

T:Teaching, R: Recitation, L: Laboratory

2.8 3rd Year – 5th Semester

MN	MODULES	HOURS/WEEK T	R	L	TU	ECTS	INSTRUCTOR
	COMPULSORY MODULES						
CHM_550	Fluid Mechanics	3	2	_	4	6	I. Tsamopoulos
CHM_570	Polymer Science & Technology	3	1	_	4	5	G. Pasparakis
CHM_540	Technical Thermodynamics and Balances	3	2	_	4	6	D. Vayenas - V. Mavrantzas
CHM_381	Materials Science	3	2	_	4	6	K. Dassios - S. Kennou
CHM_680	Microbiology	3	_	_	3	4	M. Dimarogona
CHM_481	Materials Laboratory	_	_	4	2	3	A. Christogerou
	SUM				21	30	

2.9 3rd Year – 6th Semester

MN	MODULES	HOURS/WEEK T	R	L	TU	ECTS	INSTRUCTOR
	COMPULSORY MODULES						
CHM_650	Heat Transfer	3	2	_	4	6	I. Tsamopoulos
CHM_755	Mass Transfer	2	1	_	3	4	I. Kookos
CHM_515	Instrumental Chemical Analysis	2	2	_	3	4	G. Kyriakou
CHM_741	Chemical Reaction Engineering I	3	1	_	4	6	A. Katsaounis
CHM_840	Process Dynamics and Control	3	2	1	5	7	M. Kornaros - S. Pavlou
CHM_671	Polymers Laboratory	_	_	4	2	3	K. Dassios - G. Pasparakis
	SUM				21	30	

T:Teaching, R: Recitation, L: Laboratory

2.10 4th Year - 7th Semester

MN	MODULES	HOURS/WEEK T	R	L	TU	ECTS	INSTRUCTOR
	COMPULSORY MODULES						
CHM_655	Unit Operations I	2	2	2	4	6	Ch. Paraskeva
CHM_742	Biochemical Process Engineering	3	2	_	4	6	M. Dimarogona
CHM_941	Process and Plant Design	4	1	_	5	6	I. Kookos
CHM_756	Chemical Engineering Processes Laboratory I	_	_	4	2	3	D. Vayenas - Ch. Paraskeva
CHM_841	Chemical Reaction Engineering II	3	2	_	4	6	S. Bebelis - G. Kyriakou

T:Teaching, R: Recitation, L: Laboratory

MN	MODULES	T	R	L	TU	ECTS	INSTRUCTOR
	ELECTIVES: GROUP B						
CHM_795	Production and Project Management	3	_	_	3	3	MEAD
CHM_796	Introd. to Business Administration	3	_	_	3	3	MEAD
CHM_798	General Ecology	3	_	_	3	3	DBIOL
CHM_799	Operational Research	3	_	_	3	3	BMA
CHM_780	Introduction to Economics for Engineers and Scientists	3	_	_	3	3	DECON
CHM_781	Introduction to Business Administration for Engineers and Scientists	3	_	_	3	3	BMA

	TU	ECTS
SUM	22	30

NOTES:

Two (2) modules must be elected from the ELECTIVES:GROUP B, specifically one module from the electives of the 7th semester and one module from the electives of the 8th semester.
Either CHM_799 (7th semester) or CHM_885 (8th semester) can be selected

2.11 4th Year – 8th Semester

MN	MODULES	HOURS/WEEK T	R	L	TU	ECTS	INSTRUCTOR
	COMPULSORY MODULES						
CHM_1041	Plant Design and Economics Lab.	4	_	4	6	10	I. Kookos - E. Amanatides D. Vayenas - M. Dimarogona A. Katsaounis - G. Kyriakou M. Kornaros - D. Mantzavinos
CHM_846	Chemical Engineering Process Laboratory II	_	_	4	2	3	K. Dassios - M. Dimarogona
CHM_855	Unit Operations II	2	2	2	4	6	Ch.Paraskeva
CHM_835	Industrial Chemical Technologies	3	1	_	4	5	D. Vayenas - D. Spartinos
CHM_884	Process Health and Safety	3	_	_	3	3	D. Vayenas

T:Teaching, R: Recitation, L: Laboratory

MN	MODULES	T	R	L	TU	ECTS	INSTRUCTOR
	ELECTIVES: GROUP B						
CHM_881	Management Information Systems	3	_	_	3	3	MEAD
CHM_882	Operations Strategy	3	_	_	3	3	MEAD
CHM_883	Technology - Innovation - Entrepreneurship	3	_	_	3	3	MEAD
CHM_885	Operations Research I	3	_	_	3	3	MEAD
CHM_797	Technical Project Management	2	1	_	3	3	CIVIL
CHM_886	Organisms, Populations & Environment	3	_	_	3	3	DBIOL
CHM_898	Practical Training in Industry & Enterprises	3	_	_	3	3	G. Angelopoulos

SUM	22	30

2.12 5th Year – 9th Semester

MN	MODULES	HOURS/WEEK T	R	L	TU	ECTS	INSTRUCTOR
	COMPULSORY MODULES						
CHM_Δ01	Diploma Thesis I	_	_	_	4	3	Supervisor
CHM_Δ02	Diploma Thesis II	_	_	_	4	3	Supervisor
CHM_Δ03	Diploma Thesis III	_	_	_	4	3	Supervisor
CHM_Δ04	Diploma Thesis IV	_	_	_	4	3	Supervisor
CHM_Δ05	Diploma Thesis V	_	_	_	4	3	Supervisor
CHM_Δ06	Diploma Thesis VI	_	_	_	4	3	Supervisor
	THEMATIC UNIT ELECTIVES						
CHM_E_A1	Wastewater Engineering	3	_	_	3	4	M. Kornaros D. Mantzavinos
CHM_E_A2	Process Optimization and Control	3	_	_	3	4	I. Kookos
CHM_E_A3	Bioreactor Analysis and Design	3	_	_	3	4	S. Pavlou
CHM_E_B1	Heterogeneous Catalysis	3	_	_	3	4	S. Bebelis
CHM_E_B2	Molecular Spectroscopy	3	_	_	3	4	S. Boghosian
CHM_E_B3	Surface Science	3	_	_	3	4	G. Kyriakou
CHM_E_Γ1	Production & Shaping of Industrial Materials	3	_	_	3	4	G. Angelopoulos Y. Dimakopoulos P. Nikolopoulos
CHM_E_Γ2	Nanomaterials & Nanotechnology	3	_	_	3	4	C. Galiotis S. Kennou
CHM_E_Γ2	Biomaterials	3	_	_	3	4	E. Amanatides G. Pasparakis
	SUM				33	30	

NOTES:
The electives offered in the 9th and 10th semester are allocated in three (3) Thematic Units:

A. Process and Environmental Engineering
B. Applied Physical Chemistry - Chemical and Electrochemical Reaction Engineering
Γ. Materials Science and Technology

Six (6) elective modules that are related to the subject of the Diploma Thesis must be elected from the THEMATIC UNIT ELECTIVES, specifically three (3) in the 9th and three (3) in the10th semester. The selection process is as follows: two (2) modules are selected by the supervisor of the Diploma Thesis, another two (2) modules are selected by the student from the electives of the thematic unit associated with the Diploma Thesis, and the remaining two (2) can be selected from any of the remaining electives, under the restriction that the depth and breadth outcomes in the selected electives (as described in the Departmental Curriculum) are balanced within 20%.

The content and layout of the Diploma Thesis need to conform to specific template and guidelines, which are clearly described in a manual uploaded in the ChemEngUP website. The Diploma Thesis is examined by a committee of three (3) examiners, two permanent members and the supervisor, which, for a given academic year, is assigned to assess all Diploma Theses associated with a thematic unit. The examiners consult a marking scheme and procedure for marking the thesis and the related oral examination. Plagiarism is checked using pertinent software tools available both to students and faculty.

2.13 5th Year – 10th Semester

MN	MODULES	HOURS/WEEK T	R	L	TU	ECTS	INSTRUCTOR
	COMPULSORY MODULES						
CHM_Δ07	Diploma Thesis VII	_	_	_	4	3	Supervisor
CHM_Δ08	Diploma Thesis VIII	_	_	_	4	3	Supervisor
CHM_Δ09	Diploma Thesis IX	_	_	_	4	3	Supervisor
CHM_Δ10	Diploma Thesis X	_	_	_	4	3	Supervisor
CHM_Δ11	Diploma Thesis XI	_	_	_	4	3	Supervisor
CHM_Δ12	Diploma Thesis XII	_	_	_	4	3	Supervisor
	THEMATIC UNIT ELECTIVES						
CHM_E_A4	Applications & Simulation of Transport Phenomena	3	_	_	3	4	Y. Dimakopoulos
CHM_E_A5	Solid Wastes Management	3	_	_	3	4	M. Kornaros
CHM_E_A6	Air Pollution Management	3	_	_	3	4	S. Pandis
CHM_E_B4	Reactor Analysis and Design	3	_	_	3	4	S. Bebelis - D. Spartinos
CHM_E_B5	Electrochemical Processes	3	_	_	3	4	S. Bebelis
CHM_E_B6	Suspensions and Emulsions	3	_	_	3	4	P. Koutsoukos
CHM_E_Γ4	Microelectronics Technology	3	_	_	3	4	E. Farsari
CHM_E_Γ5	Corrosion and Materials Protection	3	_	_	3	4	K. Dassios
CHM_E_Γ6	Materials for Energy Applications	3	_	_	3	4	K. Dassios – C. Galiotis
	SUM				33	30	

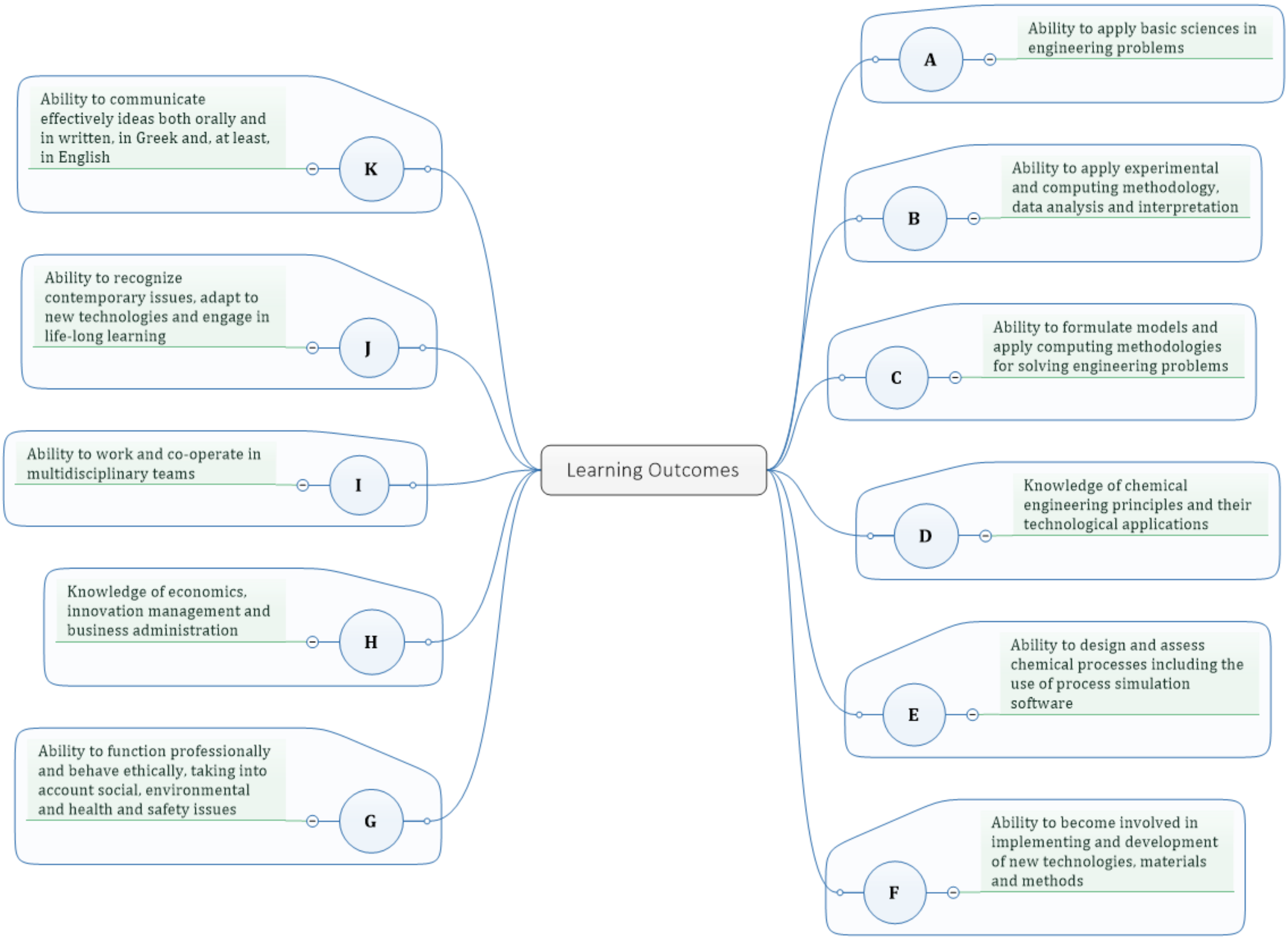
T:Teaching, R: Recitation, L: Laboratory

2.14 Thematic Unit Electives

MN	MODULES	HOURS/WEEK T	R	L	TU	ECTS
THEMATIC UNIT A: PROCESS & ENVIRONMENTAL ENGINEERING						
CHM_E_A1	Wastewater Engineering	3	_	_	3	4
CHM_E_A2	Process Optimization and Control	3	_	_	3	4
CHM_E_A3	Bioreactor Analysis and Design	3	_	_	3	4
CHM_E_A4	Applications & Simulation of Transport Phenomena	3	_	_	3	4
CHM_E_A5	Solid Wastes Management	3	_	_	3	4
CHM_E_A6	Air Pollution Management	3	_	_	3	4
THEMATIC UNIT B: APPLIED PHYSICAL CHEMISTRY - CHEMICAL & ELECTROCHEMICAL REACTION ENGINEERING						
CHM_E_B1	Heterogeneous Catalysis	3	_	_	3	4
CHM_E_B2	Molecular Spectroscopy	3	_	_	3	4
CHM_E_B3	Surface Science	3	_	_	3	4
CHM_E_B4	Reactor Analysis and Design	3	_	_	3	4
CHM_E_B5	Electrochemical Processes	3	_	_	3	4
CHM_E_B6	Suspensions and Emulsions	3	_	_	3	4
THEMATIC UNIT Γ: MATERIALS SCIENCE & TECHNOLOGY						
CHM_E_Γ1	Production & Shaping of Industrial Materials	3	_	_	3	4
CHM_E_Γ2	Nanomaterials & Nanotechnology	3	_	_	3	4
CHM_E_Γ2	Biomaterials	3	_	_	3	4
CHM_E_Γ4	Microelectronics Technology	3	_	_	3	4
CHM_E_Γ5	Corrosion and Materials Protection	3	_	_	3	4
CHM_E_Γ6	Materials for Energy Applications	3	_	_	3	4

3. MODULE DESCRIPTIONS

3.1 Categories of Learning Outcomes (CAT)



3.2 1st Year – 1st Semester

Single Variable Calculus and Linear Algebra

Module code	**CHM_102**			
Module title	***Single Variable Calculus and Linear Algebra***			
Status	Live	**Type**	Compulsory	
Category A	Underpinning Mathematics, Science and Associated engineering		**%**	100%
Category B			**%**	%
Year of study	1	**Semester**	Fall	
ECTS credits	6	**Teaching Units**	5	
Name of lecturer	Panayiotis Vafeas			
Learning outcomes	**CAT**	**Description**		
	A	Knowledge of the new notions in the form of definitions and theorems that concern the basic contents of the module "Single Variable Calculus and Linear Algebra", in order to be able to apply them.		
	F	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.		
	I	Ability tocombine 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 module are necessary and usefulto multidisciplinary subjects.		
	I	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		
	A	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.		
	F	Study skills needed for continuing profession development.		
Competences Prerequisites	There are no prerequisite modules. 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.			
Module content	Introduction to the calculus of one variable. Functions of one variable, the conception of representation, limit and continuity. Derivative of first or higher order of functions, 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. 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. 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 vectors, inner, exterior, mixed and double–exterior product, geometrical meaning. Matrix theory and square matrices, determinant			

Module code	CHM_102			
	and inverse matrix. Vector spaces, 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' method. Spectral analysis of matrix, eigenvalues and eigenvectors, physical meaning and 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[8] literature	1. Β. Β. Μάρκελλος, "Εφαρμοσμένα Μαθηματικά", Εκδόσεις Γκότσης Κων/νος & ΣΙΑ Ε.Ε., Πάτρα, 2013.			
	2. Κ. Ε. Παπαδάκης, "Εφαρμοσμένα Μαθηματικά", Εκδόσεις Α. Τζιόλας & Υιοί Α.Ε., Θεσσαλονίκη, 2014.			
	3. Δ. Γεωργίου, Σ. Ηλιάδης και Α. Μεγαρίτης, "Πραγματική Ανάλυση", Εκδόσεις Α. Τζιόλας & Υιοί Α.Ε., Θεσσαλονίκη, 2018			
	4. Ν. Μυλωνάς, Χ. Σχοινάς και Γ. Παπασχοινόπουλος, "Λογισμός Συναρτήσεων Μιας Μεταβλητής & Γραμμική Άλγεβρα", Εκδόσεις Α. Τζιόλας & Υιοί Α.Ε., Θεσσαλονίκη, 2017.			
Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	4 h/w	2 h/w	2 h/w	0/semester
Assessment type	Written Examination			
Assessment and grading methods	Final written and/or oral exam			
Instruction Language	Greek			
Erasmus availability	NO			
Module URL	http://www.chemeng.upatras.gr/en/content/modules/en/single-variable-calculus-and-linear-algeb			
Last Amendment	December 2016			

Analytical Chemistry

Module code	CHM_115			
Module title	***Analytical Chemistry***			
Status	Live	**Type**	Compulsory	
Category A	Underpinning Mathematics, Science and Associated engineering		**%**	100%
Category B			**%**	%
Year of study	1	**Semester**	Fall	
ECTS credits	4	**Teaching Units**	3	
Name of lecturer	Eleftherios Amanatides			
Learning outcomes	**CAT**	**Description**		
	A	Comprehension of the principles of chemical equilibrium, with application in solutions of electrolytes		
	A	Extended and in depth study of the ionic equilibriums		
	A	Calculation of concentrations from equilibrium constants		

Module code	**CHM_115**	
	A	Comprehension of basic concepts of analytical chemistry, which find application in qualitative, as well in quantitative analysis.
Competences Prerequisites	There are no prerquisite modules. Students should have a basic knowledge of chemistry	
Module content	Introductory concepts. Solutions. The 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[8] literature	1. "Χημική Ισορροπία και Ανόργανη Ποιοτική Ημιμικροανάλυση", Μέρος πρώτο, Θ.Π. Χατζηιωάννου, Αθήνα, 1996.	
	2. "Αναλυτική Χημεία, Θέματα και Προβλήματα", Στυλιανός Λιοδάκης, Παπασωτηρίου Εκδόσεις, 2001.	

Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	2 h/w	1 h/w	0 h/w	0/semester
Assessment type[9]	Written Examination			
Assessment and grading methods	Final written and/or oral exam			
Instruction Language	Greek			
Erasmus availability	NO			
Module URL	https://eclass.upatras.gr/modules/CMNG2139			
Last Amendment	June 2016			

Introduction to Chemical Engineering

Module code	**CHM_140**			
Module title	***Introduction to Chemical Engineering***			
Status	**Live**	**Type**	Compulsory	
Category A	Core Chemical Engineering		**%**	90%
Category B	Chemical Engineering Design Practice and Design Projects		**%**	10%
Year of study	1	**Semester**	Fall	
ECTS credits	4	**Teaching Units**	4	
Name of lecturer	Dimitris Vayenas, Alexandros Katsaounis			

Learning outcomes	**CAT**	**Description**
	A	Understand a flowsheet of a simple Chemical Industry. Develop the physical and mathematical model of a process
	A	Use fundamental equations and write mass and energy balances in simple processes. Understand the concept of linearization.
	B	Use differential and integral methods for the treatment of reaction rate data.

Module code	**CHM_140**	
	B	Use dimensional analysis in order to extract equations.
	D	Write mass and energy balances of chemical compounds in simple physical processes and simple chemical reactors.
	C	Design an ideal isothermal reactor for a specific process.
Competences Prerequisites	No	
Module content	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 modules 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. How to design an ideal isothermal reactor for a specific process. Dimensional analysis. The concept of scale-up. The concept of linearization. Residence time distribution (RTD) in simple single- and multi-chemical reactors.	
Recommended literature	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**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	3 h/w	2 h/w	0 h/w	3/semester

Assessment type[9]	Combined
Assessment and grading methods	Problem solving by the students during the semester. One elementary project focusing on the design of an ideal isothermal reactor for a specific process (1 unit bonus on the final mark, if it is > 5). Written examination in the middle of the semester (50% of the final mark) Final written exam (50 % of the final mark)
Instruction Language	Greek
Erasmus availability	NO
Module URL	https://eclass.upatras.gr/modules/CMNG2141/
Last Amendment	January 2017

Physics I

Module code	**CHM_130**		
Module title	***Physics I***		
Status	Live	**Type**	Compulsory
Category A	Underpinning Mathematics, Science and Associated engineering	**%**	100%
Category B		**%**	%
Year of study	1	**Semester**	Fall
ECTS credits	5	**Teaching Units**	4
Name of lecturer	Dimitris Kouzoudis		

<table>
<tr><td>Module code</td><td colspan="4">CHM_130</td></tr>
<tr><td rowspan="4">Learning outcomes</td><td>CAT</td><td colspan="3">Description</td></tr>
<tr><td>A</td><td colspan="3">Ability to apply basic sciences in engineering problems</td></tr>
<tr><td>B</td><td colspan="3">Ability to apply experimental and computing methodology, data analysis and interpretation</td></tr>
<tr><td>C</td><td colspan="3">Ability to formulate models and apply computing methodologies for solving engineering problems</td></tr>
<tr><td>Competences Prerequisites</td><td colspan="4">Basic High School Algebra, Geometry and Mathematics</td></tr>
<tr><td>Module content</td><td colspan="4">Introduction: Units vectors and differential calculus.
Motion in 1 dimension: Random motion (variable speed, variable acceleration). Distance, displacement, instantaneous and average speed, acceleration. Differentiation and Integration in Physics.
Motion in 2 dimensions: Vectors in 2 dimensions. Position vector, velocity and acceleration. Trajectory and constant speed circular motion.
Mechanical forces: Friction, vertical reaction, spring force, contact forces, gravity, string tension.
Newton's laws: First, second and third law of Newton in 1 and 2 dimensions. Applications
Circular motion: Centripetal force, centripetal acceleration. Degrees and radians, angular velocity and angular acceleration. Connection to linear quantities.
Work-Energy: Work definition. Power. Kinetic energy and work-energy theorem. Conservative systems and dynamic energy. Conservation of mechanical energy. Non-conservative systems. Έργο-Ενέργεια.
Momentum: Impulse and momentum theorem. Conservation of momentum.
Rotational motion. Rotation of a Solid around a fixed axis. Rotational kinetic energy, work and power. Moment of inertia. Torque. Newton's 2nd law in rotation. Static Equilibrium
Angular momentum: Definition. Angular momentum and torque. Central powers and conservation of angular momentum.
Composite motion. Transport equations and rotational motion. Center of mass of the solid. Rolling.
Oscillations: Simple harmonic oscillator. Energy of an oscillator. Pendulum motion. Damped Oscillations. Resonance. Small oscillations. Beat.
Mechanical waves: Wave Speed. Mathematical expression. Harmonic waves. Longitudinal-transverse waves. Waves on strings, sound waves. Reflection and superposition. Standing waves. Doppler Effect.</td></tr>
<tr><td rowspan="3">Recommended[8] literature</td><td colspan="4">1. "Physics for scientists and engineers", D. C. Giancoli</td></tr>
<tr><td colspan="4">2." Physics", Part I, D. Halliday, R. Resnick, J. Walker</td></tr>
<tr><td colspan="4">3. "University Physics: with Modern Physics", H. D. Young, R. A. Freedman</td></tr>
<tr><td></td><td colspan="4">4. ΦΥΣΙΚΗ Ι (Μηχανική - Κυματική), Δ. Κουζούδης, Π. Πετρίδης</td></tr>
<tr><td rowspan="2">Teaching and learning methods</td><td>LECTURES</td><td>RECITATION</td><td>LAB/PRACTICE</td><td>PROJECT / HOMEWORK</td></tr>
<tr><td>3 h/w</td><td>1 h/w</td><td>0 h/w</td><td>0/semester</td></tr>
<tr><td>Assessment type</td><td colspan="4">Written Examination</td></tr>
<tr><td>Assessment and grading methods</td><td colspan="4">Final written and/or oral exam</td></tr>
<tr><td>Instruction Language</td><td colspan="4">Greek</td></tr>
<tr><td>Erasmus availability</td><td colspan="4">YES</td></tr>
<tr><td>Module URL</td><td colspan="4">https://eclass.upatras.gr/courses/CMNG2162/</td></tr>
<tr><td>Last Amendment</td><td colspan="4">December 2016</td></tr>
</table>

General and Inorganic Chemistry

<table>
<tr><td>Module code</td><td colspan="4">CHM_110</td></tr>
<tr><td>Module title</td><td colspan="4">GENERAL AND INORGANIC CHEMISTRY</td></tr>
<tr><td>Status</td><td colspan="2">Live</td><td>Type</td><td>Compulsory</td></tr>
<tr><td>Category A</td><td colspan="2">Underpinning Mathematics, Science and Associated engineering</td><td>%</td><td>100%</td></tr>
<tr><td>Category B</td><td colspan="2"></td><td>%</td><td>%</td></tr>
<tr><td>Year of study</td><td colspan="2">1</td><td>Semester</td><td>Fall</td></tr>
<tr><td>ECTS credits</td><td colspan="2">5</td><td>Teaching Units</td><td>4</td></tr>
<tr><td>Name of lecturer</td><td colspan="4">Dimitris Kondarides</td></tr>
<tr><td rowspan="7">Learning outcomes</td><td>CAT</td><td colspan="3">Description</td></tr>
<tr><td>A</td><td colspan="3">Understand fundamentals of atomic structure and of the steps leading to the development of modern atomic theories</td></tr>
<tr><td>A</td><td colspan="3">Understanding bonding in molecules and of the way that electro distribution in atoms in their compounds affects molecular shape and other macroscopic properties of materials</td></tr>
<tr><td>A</td><td colspan="3">Understanding and predicting macroscopic properties of materials on the basis of intermolecular forces</td></tr>
<tr><td>A</td><td colspan="3">Ability for use of the information involved in the periodic table of the elements for the prediction of physical, chemical properties of materials, their reactivity and of the electronic structure of the atoms.</td></tr>
<tr><td>A</td><td colspan="3">Understanding of the importance of interactions at the atomic and molecular level for the prediction of physical and chemical properties of materials.</td></tr>
<tr><td>I</td><td colspan="3">Relating knowledge of physical and chemical phenomena with everyday life.</td></tr>
<tr><td>Competences Prerequisites</td><td colspan="4">General Chemistry (High School level)</td></tr>
<tr><td>Module content</td><td colspan="4">Atoms, molecules and ions. Early atomic theories. From ancient Greeks to the modern atomic theories. Quantum principles. Thomson's experiment. Millikan experiment. Discreetness of atomic spectra. Planck's theory. Atomic models of J.J.Thomson, Rutherford, N.Bohr.
The De Broglie theory and atomic model. Where are the electrons? Atomic orbitals and quantum numbers. The properties of atomic orbitals. The pauli and Hund's rules. The effective nuclear charge. Shielding and penetration. The aufbau principle for the electronic conformation of atoms. Exceptions from the rules. Pseudonoble gas configuration. The electronic configuration of ions. Atomic structure and the periodic table. Properties of the elements and periodic trends of their physical and chemical properties. Chemical bonding. Lewis structures. Formal charges and oxidation number. Resonance. VSEPR theory. Molecular geometry. Valence bond theory. Hybridization of atomic orbitals. Molecular orbital theory. The LCAO method. Modern aspects of chemical bond. Forces between atoms and molecules and their consequences to physical properties of materials.. Solids and Liquids. Elements of chemical thermodynamics and chemical kinetics.Chemical Equilibrium. Acids, bases and salts. The strength of acids and bases. Complexes of the elements of the d-block.</td></tr>
<tr><td rowspan="2">Recommended literature</td><td colspan="4">1. Ebbing: General Chemistry, 4th Ed. , Houghton, 1993.</td></tr>
<tr><td colspan="4">2. Εφαρμοσμένη Ανόργανη Χημεία, Σ.Λιοδάκης, Εκδ. Παρισιάνου 2003</td></tr>
<tr><td rowspan="2">Teaching and learning methods</td><td>LECTURES</td><td>RECITATION</td><td>LAB/PRACTICE</td><td>PROJECT / HOMEWORK</td></tr>
<tr><td>3 h/w</td><td>1 h/w</td><td>0 h/w</td><td>2/semester</td></tr>
<tr><td>Assessment type</td><td colspan="4">Combined</td></tr>
</table>

Module code	**CHM_110**			
Assessment and grading methods	Short, 15 min exams are given during the semester (8-10 exams). 15% of the average is added to the final exam mark. 2 homework assignments, 10% of the average is added to the final exam mark. Final written and/or oral examination			
Instruction Language	Greek			
Erasmus availability	YES			
Module URL	https://eclass.upatras.gr/courses/CMNG2122/			
Last Amendment	December 2016			

Computers Laboratory

Module code	**CHM_163**			
Module title	***Computers Laboratory***			
Status	Live	**Type**	Compulsory	
Category A	Underpinning Mathematics, Science and Associated engineering		**%**	100%
Category B			**%**	%
Year of study	1	**Semester**	Fall	
ECTS credits	3	**Teaching Units**	2	
Name of lecturer	Ergina Farsari			
Learning outcomes	**CAT**	**Description**		
	B	Ability to use Excel for data analysis and presentation		
	B	Ability to use Matlab for data analysis and presentation		
	C	Ability to use Matlab as a tool for solving basic engineering problems		
	K	Writing and presentation of original reports		
Competences Prerequisites	General computing skills (High School level)			
Module content	• Introduction to engineering computation. Analytical vs algorithmic problem solving. Data retrieval, analysis and visualization. • Introduction to EXCEL, using the spreadsheet, data formatting, excel functions, logic expressions, iterative solution, lookup tables, linear regression, using the solver, data visualization in EXCEL. • Introduction to MATLAB, command line processing, script files, function files, vectors and 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.			
Recommended literature	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. Υπολογιστική Μηχανική με Matlab και Excel, J. C. Musto, W. E. Howard and R. R. Williams, Εκδόσεις Τζιόλα. ISBN 978-960-418-504-7			
Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	1 h/w	0 h/w	2 h/w	6/semester
Assessment type	During the semester			

Module code	**CHM_163**			
Assessment and grading methods	Average mark of six original homework reports based on individual data retrieval, analysis and presentation			
Instruction Language	Greek and English			
Erasmus availability	YES			
Module URL	https://eclass.upatras.gr/courses/CMNG2112/			
Last Amendment	December 2016			

History of Technology I

Module code	**CHM_185**			
Module title	***History of Technology I***			
Status	Live	**Type**	Elective	
Category A	Foreign Language & Social Sciences		**%**	100%
Year of study	1	**Semester**	Fall	
ECTS credits	3	**Teaching Units**	3	
Name of lecturer(s)	Department of Mechanical Engineering & Aeronautics			

Introduction to Philosophy

Module code	**CHM_186**			
Module title	***Introduction to Philosophy***			
Status	Live	**Type**	Elective	
Category A	Foreign Language & Social Sciences		**%**	100%
Year of study	1	**Semester**	Fall	
ECTS credits	3	**Teaching Units**	3	
Name of lecturer(s)	Department of Philosophy			

Human Rights

Module code	**CHM_190**			
Module title	***Human Rights***			
Status	Live	**Type**	Elective	
Category A	Foreign Language & Social Sciences		**%**	100%
Year of study	1	**Semester**	Fall	
ECTS credits	3	**Teaching Units**	3	
Name of lecturer(s)	Department of Educational Science & Early Childhood Education			

French I

Module code	**CHM_192**			
Module title	***French I***			
Status	Live	**Type**	Elective	
Category A	Foreign Language & Social Sciences		**%**	100%

Module code	**CHM_192**				
Year of study	1	**Semester**	Fall		
ECTS credits	3	**Teaching Units**	3		
Name of lecturer(s)	Foreign Languages Teaching Unit				

German I

Module code	**CHM_193**			
Module title	***German I***			
Status	Live	**Type**	Elective	
Category A	Foreign Language & Social Sciences		**%**	100%
Year of study	1	**Semester**	Fall	
ECTS credits	3	**Teaching Units**	3	
Name of lecturer(s)	Foreign Languages Teaching Unit			

Italian I

Module code	**CHM_194**			
Module title	***Italian I***			
Status	Live	**Type**	Elective	
Category A	Foreign Language & Social Sciences		**%**	100%
Year of study	1	**Semester**	Fall	
ECTS credits	3	**Teaching Units**	3	
Name of lecturer(s)	Foreign Languages Teaching Unit			

Russian I

Module code	**CHM_195**			
Module title	***Russian I***			
Status	Live	**Type**	Elective	
Category A	Foreign Language & Social Sciences		**%**	100%
Year of study	1	**Semester**	Fall	
ECTS credits	3	**Teaching Units**	3	
Name of lecturer(s)	Foreign Languages Teaching Unit			

Introduction to Environmental Physics

Module code	**CHM_196**			
Module title	***Introduction to Environmental Physics***			
Status	Live	**Type**	Elective	
Category A	Underpinning Mathematics, Science and Associated engineering		**%**	100%
Year of study	1	**Semester**	Fall	
ECTS credits	3	**Teaching Units**	3	

Module code	**CHM_196**			
Name of lecturer(s)	Department of Physics			

Introduction to Information and Communication Technologies

Module code	**CHM_197**			
Module title	***Introduction to Information and Communication Technologies***			
Status	Live	**Type**	Elective	
Category A	Underpinning Mathematics, Science and Associated engineering		**%**	100%
Year of study	1	**Semester**	Fall	
ECTS credits	3	**Teaching Units**	3	
Name of lecturer(s)	Department of Educational Science & Early Childhood Education			

Theory of Democracy: Classical Approaches and Contemporary Problems

Module code	**CHM_198**			
Module title	***Theory of Democracy: Classical Approaches and Contemporary Problems***			
Status	Suspended	**Type**	Elective	
Category A	Foreign Language & Social Sciences		**%**	100%
Year of study	1	**Semester**	Fall	
ECTS credits	3	**Teaching Units**	3	
Name of lecturer(s)	Department of Educational Science & Early Childhood Education			

3.3 1st Year – 2nd Semester

Multivariable Calculus and Vector Analysis

<table>
<tr><td>Module code</td><td colspan="5">CHM_201</td></tr>
<tr><td>Module title</td><td colspan="5">Multivariable Calculus and Vector Analysis</td></tr>
<tr><td>Status</td><td colspan="2">Live</td><td>Type</td><td colspan="2">Compulsory</td></tr>
<tr><td>Category A</td><td colspan="3">Underpinning Mathematics, Science and Associated engineering</td><td>%</td><td>100%</td></tr>
<tr><td>Category B</td><td colspan="3"></td><td>%</td><td>%</td></tr>
<tr><td>Year of study</td><td colspan="2">1</td><td>Semester</td><td colspan="2">Spring</td></tr>
<tr><td>ECTS credits</td><td colspan="2">7</td><td>Teaching Units</td><td colspan="2">5</td></tr>
<tr><td>Name of lecturer</td><td colspan="5">Panayiotis Vafeas</td></tr>
<tr><td rowspan="7">Learning outcomes</td><td>CAT</td><td colspan="4">Description</td></tr>
<tr><td>A</td><td colspan="4">Knowledge of the new notions in the form of definitions and theorems that concern the basic contents of the module "Multivariable Calculus and Vector Analysis", in order to be able to apply them.</td></tr>
<tr><td>F</td><td colspan="4">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.</td></tr>
<tr><td>I</td><td colspan="4">Ability tocombine 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 module are necessary and usefulto multidisciplinary subjects.</td></tr>
<tr><td>I</td><td colspan="4">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.</td></tr>
<tr><td>A</td><td colspan="4">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.</td></tr>
<tr><td>F</td><td colspan="4">Study skills needed for continuing profession development.</td></tr>
<tr><td>Competences Prerequisites</td><td colspan="5">There are no prerequisite modules. 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 module "Single Variable Calculus and Linear Algebra".</td></tr>
<tr><td>Module content</td><td colspan="5">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 bounded extremities, Lagrange's multipliers. Vector analysis, limit, continuity and derivative of vector functions of many variables. Position vector of particle, vector velocity and acceleration. Unit tangential and unit perpendicular vector of curve. Trihedral Frenet–Serret, curvature and turning of curve. Gradient of scalar functions, divergence and rotation 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. Geometrical applications, tangential plane and perpendicular straight line to</td></tr>
</table>

Module code	CHM_201			
	surface, tangential straight line and perpendicular plane to curve. Multiple integration of functions, double and triple integrals, change of coordinate system and 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, 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, calculation of the area of arbitrary surface in space. Gauss' and Stokes' integral theorems and their physical meaning.			
Recommended literature	1. Π. Μ. Χατζηκωνσταντίνου, "Μαθηματικές Μέθοδοι για Μηχανικούς και Επιστήμονες: Λογισμός Συναρτήσεων Πολλών Μεταβλητών και Διανυσματική Ανάλυση", Γκότσης Κων/νος & ΣΙΑ Ε.Ε., Πάτρα, 2017.			
	2. J. Hass, C. Heil και M.D. Weir, "Thomas Απειροστικός Λογισμός" (μετάφρ. Γ. Κωτσόπουλος), Ίδρυμα Τεχνολογίας & Έρευνας – Πανεπιστημιακές Εκδόσεις Κρήτης, Ηράκλειο, 2018.			
Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	4h/w	2 h/w	0 h/w	0/semester
Assessment type	Written Examination			
Assessment and grading methods	Final written and/or oral exam			
Instruction Language	Greek			
Erasmus availability	NO			
Module URL	http://www.chemeng.upatras.gr/en/content/courses/en/multivariable-calculus-and-vector-analysi			
Last Amendment	December 2016			

Organic Chemistry

Module code	CHM_212		
Module title	***Organic Chemistry***		
Status	Live	**Type**	Compulsory
Category A	Underpinning Mathematics, Science and Associated engineering	**%**	100%
Category B		**%**	%
Year of study	1	**Semester**	Spring
ECTS credits	7	**Teaching Units**	4
Name of lecturer	Eleftherios Amanatides		

Learning outcomes	CAT	Description
	A	The nomenclature and structure of organic compounds and functional groups
	A	The types of intermolecular forces and their effect on the physical properties of organic compounds
	A	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
	E	The main mechanisms of synthesis of the most important organic compounds and families

Module code	**CHM_212**
Competences Prerequisites	There are no prerequisite modules. 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)
Module content	A. Introduction to Organic Chemistry – Chemical Bonds and Molecular Structure 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 K. Alcohols-Ethers – Aldeydes – Ketones – Synthesis and Properties
Recommended literature	1. Organic Chemistry - Edition: 1st/2012 - Authors: JOHN McMurry - ISBN: 978-960-524-054-7
	2. Mechanisms of Organic Chemistry Reactions in aglance - 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	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	3 h/w	2 h/w	N h/w	10/semester

Assessment type	Combined
Assessment and grading methods	Three written exams during the semester that cover the whole module material. The students that succeed to all three exams (grade > 5) may choose not to participate to the final written and or oral exam.
Instruction Language	Greek
Erasmus availability	YES
Module URL	https://eclass.upatras.gr/courses/CMNG2116/
Last Amendment	December 2016

Laboratory of Analytical Chemistry

Module code	**CHM_215**			
Module title	***Laboratory of Analytical Chemistry***			
Status	Live	**Type**	Compulsory	
Category A	Underpinning Mathematics, Science and Associated engineering		**%**	100%
Category B			**%**	%
Year of study	1	**Semester**	Spring	
ECTS credits	3	**Teaching Units**	2	
Name of lecturer	Dimitra Kanellopoulou			

Module code	**CHM_215**			
Learning outcomes	**CAT**	**Description**		
	B	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. Familiarization with simple experimental technics. Realization of laboratory experiments and measurements. Calculations based on experimental data.		
Competences Prerequisites	Analytical Chemistry (CHM_115)			
Module content	A. 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). B. 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.			
Recommended literature	1. “Χημική Ισορροπία και Ανόργανη Ποιοτική Ημμικροανάλυση”, Μέρος δεύτερο, Θ. Π. Χατζηιωάννου, Αθήνα, 1996.			
	2. “Ποσοτική Ανάλυση”, Θ. Π. Χατζηιωάννου, Α. Κ. Καλοκαιρινός και Μ. Τιμοθέου – Ποταμιά, Αθήνα, 2006.			
	3. “Εργαστηριακές Μέθοδοι Ποσοτικής Χημικής Ανάλυσης”, Ι. Α. Στρατής, Γ. Α. Ζαχαριάδης και Α. Ν. Βουλγαρόπουλος, Εκδόσεις Ζήτη, Θεσσαλονίκη, 2000.			
Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	0 h/w	0 h/w	4 h/w	0/semester
Assessment type	Combined			
Assessment and grading methods	Evaluation of the laboratory work, 50%, written and/or oral examination, 50%			
Instruction Language	Greek			
Erasmus availability	NO			

Module code	**CHM_215**
Module URL	https://eclass.upatras.gr/courses/CMNG2140
Last Amendment	June 2016

Physics II

Module code	**CHM_230**			
Module title	***Physics II***			
Status	Live	**Type**	Compulsory	
Category A	Underpinning Mathematics, Science and Associated engineering		**%**	100%
Category B			**%**	%
Year of study	1	**Semester**	Spring	
ECTS credits	7	**Teaching Units**	4	
Name of lecturer	Dimitrios Kouzoudis			
Learning outcomes	**CAT**	**Description**		
	A	Ability to apply basic sciences in engineering problems		
	B	Ability to apply experimental and computing methodology, data analysis and interpretation		
	C	Ability to formulate models and apply computing methodologies for solving engineering problems		
Competences Prerequisites	First semester Single Variable Calculus			
Module content	Electric charge: Electrons, units of charge, conductors – insulators, Coulomb's law Electric field: Definition, calculation of electric field for point charge, thin ring, long charged line, and charged sheet. Gauss's law: Dynamic field lines, Gauss's law and applications, electric field inside conductors Electric potential energy: Gravitational potential energy and work, electric potential energy, electric potential, potential differences, voltage. Electric potential in 3-Dimensions Capacitors: Capacity, flat capacitor, other geometries, dielectrics, capacitor energy Electric current: Ohm's law, electrical resistance, resistivity, electric power, AC currents Magnetism: Introduction, force on a moving charge, cross product, force on current-carrying conductors, torque on closed loops Magnetic fields: Biot-Savart law, infinite current line, circular loop, force between straight conductors, Ampere's law, cylindrical conductors, coils and solenoids, magnetic permeability Electromagnetic Induction: Magnetic flux, Faraday's law, Lentz's law, self-inductance, coil energy Electric Circuits: Circuits with resistors, capacitors and inductors, DC circuits RC and RL, AC circuits RC, RL and RCL Light: Dual nature of light, electromagnetic waves, energy of electromagnetic waves, speed of light, refractive index Geometric Optics, law of reflection, flat and spherical mirrors, law of refraction, total reflection and critical angle, thin lenses Wave Optics: Interference, Young's double slit experiment, diffraction from single slit			
Recommended[8] literature	1. Physics for scientists and engineers", R.A. Serway, part II			
	2. Physics", D. Halliday and R. Resnick", part II			
	3. ΦΥΣΙΚΗ ΙΙ (Ηλεκτρομαγνητισμός-Οπτική), Δ. Κουζούδης, Πετρίδης Π.			

Module code	**CHM_230**			
Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	3 h/w	1 h/w	0 h/w	0/semester
Assessment type	Combined			
Assessment and grading methods	Written and/or oral examination			
Instruction Language	Greek			
Erasmus availability	YES			
Module URL	https://eclass.upatras.gr/courses/CMNG2165/			
Last Amendment	December 2016			

Physics Laboratory

Module code	**CHM_232**			
Module title	***Physics Laboratory***			
Status	Live	**Type**	Compulsory	
Category A	Underpinning Mathematics, Science and Associated engineering		**%**	100%
Category B			**%**	%
Year of study	1	**Semester**	Spring	
ECTS credits	3	**Teaching Units**	2	
Name of lecturer	Stella Kennou, Dimitris Kouzoudis			
Learning outcomes	**CAT**	**Description**		
	A	Ability to apply basic sciences in engineering problems		
	B	Ability to apply experimental and computing methodology, data analysis and interpretation		
	C	Ability to formulate models and apply computing methodologies for solving engineering problems		
Competences Prerequisites	Basic High School Algebra, Geometry and Mathematics			
Module content	Within the context of this laboratory, the students practice in totally 8 exercises that involve the use of basic and advanced instruments in order to collect experimental data, and the writing of a lab report where the data is processed (experimental errors, capturing data in graphs and identify mathematical relationships). The exercises are: *MECHANICAL* Exercise 1 Basic physical quantities: Measuring length, time and mass *HEAT EXCHANGE* Exercise 2 Solar collector: Measuring heating rates of different surfaces *OPTICS* Exercise 3 Optical lenses: Determination of the focal length of a thin converging lens, magnification Exercise 4 Diffraction: Diffraction pattern from laser light on micro-slits (1 & 2) *ELECTROMAGNETISM* Exercise 5 Photovoltaic cell: Current-Voltage curve of a solar cell, Power Exercise 6 Capacitors: Charging and discharging capacitors in DC circuits Exercise 7 RLC circuit: Resonance of the Electrical current as a function of frequency Exercise 8 Oscilloscope functions: Using the oscilloscope in an AC circuit to measure voltages and frequencies			

Module code	**CHM_232**			
Recommended literature	1. Physics for scientists and engineers", R.A. Serway, part I & II			
	2. Physics", D. Halliday and R. Resnick", part I & II			
	3. Σημειώσεις Εργαστηρίου, Σ. Κέννου, Δ. Κουζούδης, S. Brosda			
Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	0 h/w	0 h/w	4 h/w	8/semester
Assessment type	During the semester			
Assessment and grading methods	Delivery of 8 laboratory reports and oral examination			
Instruction Language	Greek			
Erasmus availability	NO			
Module URL	https://eclass.upatras.gr/courses/CMNG2157/			
Last Amendment	December 2016			

Introduction to Science Education

Module code	**CHM_285**			
Module title	***Introduction to Science Education***			
Status	Suspended	**Type**	Elective	
Category A	Foreign Language & Social Sciences		**%**	100%
Year of study	1	**Semester**	Spring	
ECTS credits	3	**Teaching Units**	3	
Name of lecturer(s)	Department of Educational Science & Early Childhood Education			

English

Module code	**CHM_191**			
Module title	***English***			
Status	Live	**Type**	Elective	
Category A	Foreign Language & Social Sciences		**%**	100%
Year of study	1	**Semester**	Spring	
ECTS credits	3	**Teaching Units**	3	
Name of lecturer(s)	Foreign Languages Teaching Unit			

French II

Module code	**CHM_292**			
Module title	***French II***			
Status	Live	**Type**	Elective	
Category A	Foreign Language & Social Sciences		**%**	100%
Year of study	1	**Semester**	Spring	
ECTS credits	3	**Teaching Units**	3	
Name of lecturer(s)	Foreign Languages Teaching Unit			

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German II

Module code	**CHM_293**			
Module title	***German II***			
Status	Live	**Type**	Elective	
Category A	Foreign Language & Social Sciences		**%**	100%
Year of study	1	**Semester**	Spring	
ECTS credits	3	**Teaching Units**	3	
Name of lecturer(s)	Foreign Languages Teaching Unit			

Italian II

Module code	**CHM_294**			
Module title	***Italian II***			
Status	Live	**Type**	Elective	
Category A	Foreign Language & Social Sciences		**%**	100%
Year of study	1	**Semester**	Spring	
ECTS credits	3	**Teaching Units**	3	
Name of lecturer(s)	Foreign Languages Teaching Unit			

Russian II

Module code	**CHM_295**			
Module title	***Russian II***			
Status	Live	**Type**	Elective	
Category A	Foreign Language & Social Sciences		**%**	100%
Year of study	1	**Semester**	Spring	
ECTS credits	3	**Teaching Units**	3	
Name of lecturer(s)	Foreign Languages Teaching Unit			

Introduction to Educational Sciences

Module code	***CHM_296***			
Module title	**Introduction to Educational Sciences**			
Status	Live	**Type**	Elective	
Category A	Foreign Language & Social Sciences		**%**	100%
Year of study	1	**Semester**	Spring	
ECTS credits	3	**Teaching Units**	3	
Name of lecturer(s)	Department of Primary Education			

Political Sociology

Module code[1]	**CHM_297**
Module title[2]	***Political Sociology***

Module code[1]	**CHM_297**			
Status	Live	**Type**	Elective	
Category A	Foreign Language & Social Sciences		**%**	100%
Year of study	1	**Semester**	Spring	
ECTS credits	3	**Teaching Units**	3	
Name of lecturer(s)	Department of Educational Science & Early Childhood Education			

History of Technology II

Module code	**CHM_298**			
Module title	***History of Technology II***			
Status	Live	**Type**	Elective	
Category A	Foreign Language & Social Sciences		**%**	100%
Year of study	1	**Semester**	Fall	
ECTS credits	3	**Teaching Units**	3	
Name of lecturer(s)	Department of Mechanical Engineering & Aeronautics			

3.4 2nd Year – 3rd Semester

Ordinary Differential Equations

Module code	**CHM_300**			
Module title	***Ordinary Differential Equations***			
Status	Live	**Type**	Compulsory	
Category A	Underpinning Mathematics, Science and Associated engineering		**%**	100%
Category B			**%**	%
Year of study	2	**Semester**	Fall	
ECTS credits	6	**Teaching Units**	4	
Name of lecturer	Spyros Pandis			

Learning outcomes	**CAT**	**Description**
	A	Application of mathematics in the solution of engineering problems
	C	Formulation of mathematical models for the solution of engineering problems

Competences Prerequisites	Calculus and Linear Algebra
Module content[7]	Ordinary differential equations (ODEs) basic concept and ideas. First order ODEs. Separable ODEs. Exact ODEs. Linear ODEs and Bernoulli equation. Homogeneous ODEs. Special form first order ODEs. Integrating factors. Linear second order ODEs. Homogeneous linear second order equations. Second order homogeneous ODEs with constant coefficients. Non-homogeneous equations. Solution by undetermined coefficients. Solution by variation of parameters. Power series solution of differential equations. Legendre's equation. Frobenious method. Bessel's equation and functions. Laplace transforms and their properties. Transforms of step and delta functions. Solution of ODEs by Laplace transform. Systems of ODEs. Transformation of higher order ODEs to a system of first order ODEs. 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 ODEs.
Recommended literature	1. Σταυρακάκης Ν. (2015) Συνήθεις Διαφορικές Εξισώσεις, Εκδ. Παπασωτηρίου. 2. Τραχανάς Σ. (2005) Συνήθεις Διαφορικές Εξισώσεις, Παν. Εκδόσεις Κρήτης.

Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	3 h/w	2 h/w	0 h/w	10/semester

Assessment type	Written Examination
Assessment and grading methods	The results of the final written and/or oral examination are multiplied by a factor based on the performance of the student in the written tests given during the semester.
Instruction Language	Greek
Erasmus availability	NO
Module URL	https://eclass.upatras.gr/courses/CMNG2174/
Last Amendment	December 2016

Organic Chemistry Laboratory

Module code	**CHM_311**			
Module title	***Organic Chemistry Laboratory***			
Status	Live	**Type**	Compulsory	
Category A	Underpinning Mathematics, Science and Associated engineering		**%**	100%
Category B			**%**	%
Year of study	2	**Semester**	Fall	
ECTS credits	3	**Teaching Units**	2	
Name of lecturer	George Pasparakis			

Learning outcomes	**CAT**	**Description**
	A	Ability to organize and perform the synthesis of simple organic molecules.
	A	Ability to perform various techniques used in organic synthesis such as extraction, filtration, distillation, recrystallization etc.
	A	Abiity to perform Thin Layer Chromatography.

Competences Prerequisites	Students should have basic knowledge in Organic Chemistry.			
Module content	Synthesis of acetanilide Synthesis of tert- boutylchloride Nitration of acetanilide The Cannizzaro reaction The Claisen- Schmidt reaction Synthesis of oxime of cyclohaxanone Thin Layer Chromatography (TLC)			
Recommended literature	1. Laboratory Notes			
	2. D.L. PAIVA, G.M. LAMPMAN and G.S. KRIZ "Introduction to Organic Laboratory Techniques", New York (1998).			
	3. I.M. HARWOOD, C.J. MOODY and J.M. PERCY "Experimental Organic Chemistry", London (1995).			
Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	0 h/w	0 h/w	4 h/w	0/semester
Assessment type	Combined			
Assessment and grading methods	Written test before performing the day's experiment (25% of the final grade), Lab report (25% of the final grade), Final written and or oral examination (50% of the final grade).			
Instruction Language	Greek			
Erasmus availability	YES			
Module URL	https://eclass.upatras.gr/courses/CMNG2164/			
Last Amendment	January 2017			

Thermodynamics I

Module code	**CHM_220**			
Module title	***Thermodynamics I***			
Status	**Live**	**Type**	Compulsory	
Category A	Core Chemical Engineering		**%**	100%

Module code	**CHM_220**					
Category B					**%**	%
Year of study	2			**Semester**	Fall	
ECTS credits	6			**Teaching Units**	4	
Name of lecturer(s)	Soghomon Boghosian					
Learning outcomes	**CAT**	**Description**				
	A	Ability to use mathematic tools for deriving Thermodynamics through introduction of new functions and through correlations using partial derivatives				
	C	Ability to perform calculations of changes in thermodynamic functions, work and heat in simple (non-chemical) processes				
	D	Ability to perform technical calculations in processes involving phase transitions				
Competences Prerequisites	The students are expected to have a good command of differential equations and integrals.					
Module content	FOUNDATION OF THERMODYNAMICS. Thermodynamic systems and variables. Zeroth Law and temperature. Work. Internal Energy and First Law. Heat. Spontaneous and non-spontaneous processes. The Entropy and the Second Law. Reversibility. Clausius inequality. Fundamental thermodynamic equation in internal energy representation. Cyclic processes. Legendre transformations. 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. Heat 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. 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.					
Recommended literature	1. J. M. Smith, H. Van Ness, M. M. Abbott, «Introduction to Chemical Engineering Thermodynamics» (translated in greek), A. Tziola & Sons Editions, 2011.					
	2. Α. Παπαϊωάννου, «Θερμοδυναμική – Τόμος Ι», Εκδόσεις Γκελμπέση, 2007					
Teaching and learning methods	**LECTURES**		**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**	
	3 h/w		2 h/w	0 h/w	1/semester	
Assessment type[9]	Combined					
Assessment and grading methods	1) The student can take two (2) tests on volunteer basis (6th and 13th week of the semester). 2) Undertaking of case studies/projects by small (3,4) student groups, on volunteer basis. 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 module grade.					
Instruction Language	Greek					
Erasmus availability	YES					
Module URL	https://eclass.upatras.gr/courses/CMNG2180/					
Last Amendment	January 2017					

Computer Programming for Chemical Engineers

Module code	**CHM_363**			
Module title	***Computer Programming for Chemical Engineers***			
Status	**Live**	**Type**	Compulsory	
Category A	Underpinning Mathematics, Science and Associated engineering		**%**	100%
Category B			**%**	%
Year of study	2	**Semester**	Fall	
ECTS credits	6	**Teaching Units**	5	
Name of lecturer(s)	Dimitris Mataras			

Learning outcomes	**CAT**	**Description**
	B	Ability to use compilers through an Integrated Development Environment for formulating basic science and engineering problems in a high level computer language
	B	Ability to understand and use basic numerical algorithms
	C	Ability to solve engineering problems using computer programming
	K	Ability to present written and/or oral original homework and (optionally) mini project reports

Competences Prerequisites	CHM_163 Computers Laboratory
Module content	Computer Programming and Chemical Engineering. Algorithms: categories, data structures, design techniques, performance analysis. Elements of Fortran 95/2003/2008 with selective presentation of elemental C++. 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. Masked array assignment (where, forall). Procedures: functions, subroutines, elemental and recursive procedures. Dynamic Data Structures: dynamic arrays, allocatable, assumed shape and automatic arrays, pointers, lists. Derived data types. Modules: module procedures, data range and association, procedure interfaces, user defined and overloaded operators, generic procedures. Object Oriented Programming: encapsulation, polymorphism, inheritance. Basic algorithm examples: search and sort, random numbers, equation solving, integration, data visualization using Excel and GNUPLOT. Keywords: Computer Programming, Algorithms, Fortran 2008
Recommended literature	1. Προγραμματισμός Fortran 90/95 για Επιστήμονες και Μηχανικούς, Δ. Σ. Ματαράς, Φ. Α. Κουτελιέρης Εκδόσεις Τζιόλα 20011, ISBN 978-960-8050-43-3
	2. Fortran 95/2003 for Scientists and Engineers (3rd edition), S. J. Chapman. McGraw Hill 2008 978-0073191577

Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	4 h/w	0 h/w	3 h/w	8/semester

Assessment type[9]	Combined
Assessment and grading methods	1) Lab homeworks and tests account for 30% of the final mark provided the exam and lab marks are ≥ 5. 2) Mini project concerning original data analysis and presentation on volunteer basis can lead to a bonus of 30% provided the exam mark is are ≥ 4 3) Internediate written exam and Final written and/or oral exam
Instruction Language	Greek

Module code	**CHM_363**
Erasmus availability	YES
Module URL	https://eclass.upatras.gr/courses/CMNG2102/
Last Amendment	January 2017

Physical Chemistry

Module code	**CHM_421**			
Module title	***Physical Chemistry***			
Status	Live	**Type**	Compulsory	
Category A	Core Chemical Engineering		**%**	100%
Category B			**%**	%
Year of study	2	**Semester**	Fall	
ECTS credits	6	**Teaching Units**	5	
Names of lecturers	Dimitris Kondarides - Vlasis Mavrantzas			
Learning outcomes	**CAT**	**Description**		
	A	After completing this module a student should be able to: Understand the fundamental concepts of quantum mechanics, such as the Schrödinger equation, wave function, quantization, and expectation values		
	A	Understand the quantum mechanical description of a particle's translational, rotational and vibrational motions and discuss the corresponding wavefunctions and energy levels		
	A	Grasp the concepts of spin and angular momentum and their quantization, and explain the Zeeman affect and spin-orbit coupling		
	A	Understand how quantum mechanics can be used to describe the electronic structure of hydrogenic atoms and many-electron atoms		
	A	Understand the origin of atomic and molecular spectra and discuss the selection rules governing such spectra		
	A	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		
	A	Apply principles of Statistical Thermodynamics in order to compute equilibrium constants for chemical reactions		
Competences Prerequisites				

Module code	CHM_421			
Module content	- 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.			
Recommended literature	1. P.W. Atkins and J. de Paula, "Physical Chemistry", 9th Edition, Oxford University Press, 2010 (Greek translation, 2014).			
	2. Στέφανος Τραχανάς, "Στοιχειώδης Κβαντική Φυσική", Πανεπιστημιακές Εκδόσεις Κρήτης, 2012.			
	3. B. Μαυραντζάς, "Στατιστική Θερμοδυναμική" (Statistical Thermodynamics), Hellenic Open University, Patras (2001).			
Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	4 h/w	2 h/w	0 h/w	0/semester
Assessment type	Combined			
Assessment and grading methods	3 written exams during the semester, final written and/or oral exam			
Instruction Language	Greek			
Erasmus availability	NO			
Module URL	https://eclass.upatras.gr/courses/CMNG2172/			
Last Amendment	December 2016			

English - Technical Terms for Chemical Engineers

Module code	CHM_312			
Module title	***English - Technical Terms for Chemical Engineers***			
Status	Live	**Type**	Compulsory	
Category A	Core Chemical Engineering		**%**	100%
Year of study	2	**Semester**	Spring	
ECTS credits	3	**Teaching Units**	3	
Name of lecturer(s)	Foreign Languages Teaching Unit			

3.5 2nd Year – 4th Semester

Partial Differential Equations

Module code	**CHM_402**			
Module title	***Partial Differential Equations***			
Status	Live	**Type**	Compulsory	
Category A	Underpinning Mathematics, Science and Associated engineering		**%**	100%
Category B	Choose Module Category B		**%**	%
Year of study	2	**Semester**	Spring	
ECTS credits	4	**Teaching Units**	3	
Name of lecturer	Panayiotis Vafeas			
Learning outcomes	**CAT**	**Description**		
	A	Knowledge of the new notions in the form of definitions and theorems that concern the basic contents of the module "Partial Differential Equations", in order to be able to apply them.		
	F	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.		
	I	Ability to 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 module are necessary and useful to multidisciplinary subjects.		
	I	Ability to demonstrate knowledge and understanding of essential concepts, principles and applications that are related to the partial differential equations of first and second (elliptic, parabolic and hyperbolic type) order.		
	A	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.		
	F	Study skills needed for continuing profession development.		
Competences Prerequisites	There are no prerequisite modules. It is, however, recommended that students have 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 were taught in the corresponding modules "Single Variable Calculus and Linear Algebra" and "Multivariable Calculus and Vector Analysis". Moreover, it is a requisite basic knowledge in subjects of ordinary differential equations, which were taught to the corresponding module "Ordinary Differential Equations".			
Module content	Partial differential equation and its solution, well posed problem, several methods of confrontation. Linear partial differential equations of first order and use of characteristic curves to obtain general solution, Cauchy's conditions and models of applied problems. Differential equations with partial derivatives of second order, main applications to modern technology and mathematical physics. Dirac's functional and Heaviside's function, fundamental solutions and Green's functions. Bessel's and Legendre's special functions, spherical harmonics, orthogonality and recurrence formulae. General introduction to basic integral transformations. Elliptic type equations and boundary value problems. Laplace's and Helmholtz's equations, solution with the method of separation of variables and eigenfunctions in Cartesian, polar, cylindrical and spherical coordinates with applications. Spatial Fourier's transform, fundamental solutions of Laplace's and Helmholtz's differential operators, use of the method of reflections in finding Green's function and integral representations of solutions. Parabolic type equations (diffusion equation), non homogeneous problems and dealing with the methods of asymptotic solutions and expansion to eigenfunctions, fundamental solution and integral representations of			

Module code	**CHM_402**			
	homogeneous and non homogeneous problem. Hyperbolic type equations (wave equation), principal concepts of wave propagation, finite and infinite string. Problems of parabolic and hyperbolic type with initial and boundary conditions, applications to physics with the method of separating variables and solution through Fourier's in space and Laplace's in time integral transforms.			
Recommended literature	1. Π. Μ. Χατζηκωνσταντίνου, "Μαθηματικές Μέθοδοι για Μηχανικούς και Επιστήμονες: Μερικές Διαφορικές Εξισώσεις, Σειρές Fourier & Προβλήματα Συνοριακών Τιμών – Μιγαδικές Συναρτήσεις", Εκδόσεις Γκότσης Κων/νος & ΣΙΑ Ε.Ε., Πάτρα, 2017			
	2. Σ. Τραχανάς, "Μερικές Διαφορικές Εξισώσεις", Ίδρυμα Τεχνολογίας & Έρευνας – Πανεπιστημιακές Εκδόσεις Κρήτης, Ηράκλειο, 2015.			
Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	2h/w	1 h/w	0 h/w	0/semester
Assessment type	Written Examination			
Assessment and grading methods	A final written exam is given in the end of the sementer (100% of the final grade)			
Instruction Language	Greek			
Erasmus availability	NO			
Module URL	http://www.chemeng.upatras.gr/en/content/courses/en/partial-differential-equations			
Last Amendment	December 2016			

Physical Chemistry Laboratory

Module code	**CHM_521**			
Module title	***Physical Chemistry Laboratory***			
Status	Live	**Type**	Compulsory	
Category A	Chemical Engineering Practice		**%**	100%
Category B	Choose Module Category B		**%**	%
Year of study	2	**Semester**	Spring	
ECTS credits	3	**Teaching Units**	2	
Name of lecturep	Georgios Kyriakou - Soghomon Boghosian			
Learning outcomes	**CAT**	**Description**		
	B	competence in elaborating experimental data based on pertinent theoretical principles		
	D	ability to apply principles and perform experimental measurements with precision for specific applications		
	K	competence in producing technical reports with conclusions based on elaboration of experimental measurements		
Competences Prerequisites	The students are expected to have a good command of the pertinent theoretical background of Chemical Thermodynamics and Physical Chemistry.			

Module code	**CHM_521**
Module content	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
Recommended literature	1. P. Atkins, J. de Paula, "Physical Chemistry", 9th Edition, Oxford University Press, 2014

Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	0 h/w	0 h/w	4 h/w	8/semester

Assessment type	Combined
Assessment and grading methods	1) Two (2) mandatory tests, during the 6th and 13th week of the semester (50%); 2) Oral interview while performing of the laboratory experiment (10%); 3) Written report (40%).
Instruction Language	Greek
Erasmus availability	NO
Module URL	https://eclass.upatras.gr/courses/CMNG2161/
Last Amendment	January 2017

Numerical Analysis

Module code	**CHM_660**			
Module title	***Numerical Analysis***			
Status	Live	**Type**	Compulsory	
Category A	Underpinning Mathematics, Science and Associated engineering		**%**	100%
Category B	Choose Module Category B		**%**	%
Year of study	2	**Semester**	Spring	
ECTS credits	8	**Teaching Units**	5	
Name of lecturer	Yannis Dimakopoulos			

Learning outcomes	**CAT**	**Description**
	A	Ability for deep understanding of the fundamental numerical methods.
	B	Ability to recognize the advantages and disadvantages of each method in order to decide the most convenient in use on application basis
	B	Ability to use specific software in order to develop the necessary applications
	A	Ability to analyze and interpret data

Competences Prerequisites	There are no prerequisite modules. 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)

Module code	**CHM_660**			
Module content	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.			
Recommended literature	1. Chapra S. & Canale R., "Numerical Methods for Engineers" (6th 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.			
Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	3 h/w	1 h/w	3 h/w	6/semester
Assessment type	Combined			
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).			
Instruction Language	Greek			
Erasmus availability	NO			
Module URL	https://eclass.upatras.gr/modules/auth/opencourses.php?fc=59			
Last Amendment	January 2017			

Thermodynamics II

Module code	**CHM_320**			
Module title	***Thermodynamics II***			
Status	Live	**Type**	Compulsory	
Category A	Core Chemical Engineering		**%**	100%
Category B	Choose Module Category B		**%**	%
Year of study	2	**Semester**	Spring	
ECTS credits	7	**Teaching Units**	5	
Name of lecturer	Soghomon Boghosian			
Learning outcomes	**CAT**	**Description**		
	A	Performing calculations on gas mixture systems		
	B	Undertaking thermodynamic calculations using data from Thermochemical Tables		
	C	Calculating equilibrium compositions, thermodynamic functions and reaction equilibrium conditions		
	D	Constructing partial pressure-composition diagrams in binary liquid/gas systems as well as solving problems in cryoscopic, zeseoscopic and osmotic systems		
Competences Prerequisites	The students are expected to have a good command of differential equations and integrals as well as basic knowledge of chemistry.			

Module code	CHM_320			
Module content	Partial molar properties. Gibbs-Duhem equation. 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. Van't Hoff relation. Enthalpy of reaction. General relations for the temperature dependence of Kp and ΔG. Other forms of the equilibrium constant. Standard thermodynamic functions (G, H, S) of formation. Hess' Law. Reaction equilibria involving gases with immiscible liquids and solids. Number of independent reactions. Maximum attainable yield. Le Chatelier's principle. Gibbs' Phase Rule. Degrees of freedom. Effect of inert gas on the vapor pressure of a component. General properties of solution. Partial pressure – composition relations. Raoult's and Henry's Law. Deviations. Duhem-Margules equation. Solubility. Ideal solutions. The chemical potential model for ideal solutions. Thermodynamic properties of mixing in ideal solutions. T and P 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. Gibbs – Duhem equation in representation of activity coefficients. Activity coefficients of solutes. Activity. Excess properties.			
Recommended literature	1. P. Atkins, J. de Paula, "Physical Chemistry", 9th Edition, Oxford University Press, 2014			
	2. Y.A. Cengel, M. A. Boles, «ThermodynamicsQ An Engineering Approach» 8th Edition (in Greek), A. Tziola & Sons Ed., 2016			
Teaching and learning methods	LECTURES	RECITATION	LAB/PRACTICE	PROJECT / HOMEWORK
	4 h/w	1 h/w	0 h/w	2/semester
Assessment type	Combined			
Assessment and grading methods	1) The student can take two (2) tests on volunteer basis (6th and 13th week of the semester). 2) Undertaking of case studies/projects by small (3,4) student groups, on volunteer basis. 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 module grade.			
Instruction Language	Greek			
Erasmus availability	YES			
Module URL	https://eclass.upatras.gr/courses/CMNG2181/			
Last Amendment	January 2017			

Mechanics of Materials

Module code	CHM_582			
Module title	***Mechanics of Materials***			
Status	Live	Type	Compulsory	
Category A	Underpinning Mathematics, Science and Associated engineering		%	100%
Category B	Choose Module Category B		%	%
Year of study	2	Semester	Spring	
ECTS credits	5	Teaching Units	4.	
Name of lecturer	Costas Galiotis			
Learning outcomes	CAT[5]	Description		
	A	Understand the concepts and principles applied to members under various loadings and the effects of these loadings		
	B	Analyze structural members subjected to tension, compression, torsion, bending		

Module code	**CHM_582**			
		and combined stresses using the fundamental concepts of stress, strain and elastic behavior of materials.		
	D	Analyze cylindrical vessels subjected to pressure.		
Competences Prerequisites	Students should have knowledge of mathematics and physics.			
Module content	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. Thin-walled pressure vessels 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			
Recommended literature	1. P.A. Vouthounis, Technical Mechanics, Edit. 2011. ISBN: 978-960-85431-7-1			
	2. F.P.Beer, E.R. Johnston,Jr, John T. DeWolf, D.F. Mazurek, Edit. Tziola, 2012. ISBN: 978-960-418-381-4			
Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	3 h/w	1 h/w	0 h/w	0/semester
Assessment type	Written Examination			
Assessment and grading methods	Written examination (100% of the final mark)			
Instruction Language	Greek			
Erasmus availability	YES			
Module URL	https//eclass.upatras.gr/courses/CMNG2114/			
Last Amendment	September 2016			

Statistics for Engineers

Module code	**CHM_202**			
Module title	***Statistics for Engineers***			
Status	Live	**Type**	Compulsory	
Category A	Underpinning Mathematics, Science and Associated engineering		**%**	100%
Category B	Choose Module Category B		**%**	%
Year of study	2	**Semester**	Spring	
ECTS credits	3	**Teaching Units**	3	
Name of lecturer	Spyros Pandis			

Learning outcomes	**CAT**	**Description**
	A	Application of statistics to the solution of engineering problems
	B	Application of statistical data analysis
	C	Formulation and application of statistical models in engineering problems

Competences Prerequisites	Calculus
Module content	Data analysis. Fundamental principles of probability theory. Basic theorems of probability theory. Combinatorial analysis. Discrete random variables and their distributions. Continuous random variables. Parameters of probability distributions. Normal distribution. Binomial distribution. Hypergeometric distribution. Poisson distribution. Confidence intervals. t-distribution and $\chi 2$ distribution. Hypothesis testing. Linear regression.
Recommended literature	1. Ζιούτας Γ. (2004) Πιθανότητες και Στοιχεία Στατιστικής για Μηχανικούς, εκδ. Ζήτη.
	2. Ρασσιάς Ι. (2003) Θεωρία Πιθανοτήτων και Στατιστικής, εκδ. Συμμετρία.

Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	2 h/w	1 h/w	0 h/w	6 /semester

Assessment type	Written Examination
Assessment and grading methods	The grade of the final exam is multiplied by a factor based on the performance of the student in the tests given randomly during the semester.
Instruction Language	Greek
Erasmus availability	NO
Module URL	https//eclass.upatras.gr/courses/CMNG2176/
Last Amendment	December 2016

3.6 3rd Year – 5th Semester

Fluid Mechanics

Module code	**CHM_550**			
Module title	***Fluid Mechanics***			
Status	Live	**Type**	Compulsory	
Category A	Core Chemical Engineering		**%**	100%
Category B	Choose Module Category B		**%**	%
Year of study	3	**Semester**	Spring	
ECTS credits	6	**Teaching Units**	4	
Name of lecturer	John Tsamopoulos			

Learning outcomes	**CAT[5]**	**Description**
	A	Ability to apply the basics of fluid flow and how to develop micro- & macroscopic mass & momentum balances. Understand the concept of the stress tensor and how to use it to compute the applied forces. Understand the physical significance & importance of the relevant dimensionless numbers to solve problems.
	C	Understand how to simplify practical and complicated fluid flow problems and solve them primarily analytically, but also by using appropriate numerical methods
	D	Develop the ability to simplify complex flow phenomena to simpler ones and solve the latter in simple geometries for Newtonian fluids. Develop and simplify mass and momentum balances, determine the relevant auxiliary conditions and solve the resulting equations. 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

Competences Prerequisites	CHM_102, CHM_201, CHM_300, CHM_402, CHM_130, CHM_230, CHM_220, CHM_320
Module content	INTRODUCTION. Definitions, Continuum hypothesis, Laws for solving flow problems, System or Material Volume (MV) and Control Volume (CV), Newtonian and nonNewtonian fluids. HYDROSTATICS. Differential equation of linear momentum for static fluids, Manometers, Hydrostatic forces, Buoyancy. ONE DIMENSIONAL STEADY, LAMINAR FLOWS. Analysis based on differential MV and CV, examples with Newtonian fluids. KINEMATICS. Material and Spatial coordinates, Time derivatives (partial, total, material), Velocity and acceleration, the Reynolds transport theorem, Relationship between MV and CV, Macroscopic mass balance, Continuity equation, Stream lines, Path lines, Streak lines, Stream function. MACROSCOPIC BALANCES. Linear and Angular Momentum balances. Energy balances. STRESS TENSOR. Stress at a point, symmetry of the total stress tensor, Cauchy equation. RHEOLOGICAL EQUATIONS. Rate of strain tensor, Newton's law, Dynamic and Kinematic viscosity, nonNewtonian behaviour. THE NAVIER-STOKES (NS) EQ. Derivation of NS. Dimensionless form, Reynolds, Froude, & Stokes numbers, Ideal flow, Stokes, Euler and Bernoulli equations, Potential flow, 2D incompressible flow based on the stream function. LOW Re FLOWS. Creeping flow, Flow around a sphere, lubrication flows. HIGH Re FLOWS. Boundary Layer (BL) flows, outer (potential) flows, BL detachment, exact and approximate solution of BL flow over a plate.

Module code	**CHM_550**			
Recommended literature	1. Ρευστομηχανική, Α. Παγιατάκης, Πανεπιστήμιο Πατρών			
	2. Introduction to Fluid Mechanics, 8th Ed., Fox R.W., McDonald A.T., 2012, Wiley			
	3. Transport Phenomena, Bird, Stewart, Lightfoot, Wiley			
Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	3 h/w	2 h/w	0 h/w	26/semester
Assessment type	Written Examination			
Assessment and grading methods	A final exam is given in the end of the sementer. It covers the most important topics of the module via two or three problems, which have prespecified weights. The exam is graded by the Lecturer. In the past an optional mid-term exam was given, but less than 30% of the students participated.			
Instruction Language	Greek			
Erasmus availability	YES			
Module URL	https://eclass.upatras.gr/courses/CMNG2201/			
Last Amendment	December 2016			

Polymer Science and Technology

Module code	**CHM_570**			
Module title	***Polymer Science and Technology***			
Status	Live	**Type**	Compulsory	
Category A	Core Chemical Engineering		**%**	100%
Category B	Choose Module Category B		**%**	%
Year of study	3	**Semester**	Fall	
ECTS credits	5	**Teaching Units**	4	
Name of lecturer	George Pasparakis			
Learning outcomes	**CAT**	**Description**		
	A	Be acquainted with the basic concept of polymer characterization.		
	A	Be acquainted with the chemistry of step-growth and chain-growth polymerization reactions.		
	B	Be able to extract the kinetic equations of the polymerization reactions.		
	F	Be acquainted with the basic principles of polymer characterization techniques.		
	I	Be acquainted with the states of polymers (amorphous, crystalline) and how they influence the ultimate properties in the solid state.		
	F	Understand the basic principles of polymer viscoelasticity		
	I	Comprehend and use the basic principles of statistical thermodynamics of macromolecular solutions.		
Competences Prerequisites	Students should have at least basic knowledge of Organic Chemistry, Physical Chemistry and Thermodynamics.			

Module code	**CHM_570**			
Module content	Nomenclature of macromolecules, degree of Polymerization, Average molecular weights, classification of polymerization reactions, macromolecular architecture, copolymers, isomerism of macromolecules. Chemistry of step-growth polymerization, Monomers and general schemes of step-growth reactions, crosslinked polymers (thermosettings). Kinetics of step-growth polymerization, kinetics of gelation reactions. Chemistry of chain-growth radical polymerization, controlled free radical polymerization. Kinetics of chain-growth polymerization, Kinetic scheme (initiation, propagation, termination) polymerization rate, evaluation of kinetic constants, degree of polymerization of products DPn, DPw versus monomer conversion relationships, the Trommsdorff effect, influence of chain transfer reactions on the kinetic equation. Kinetics of radical copolymerization, Kinetic scheme, reactivity ratios. Statistical thermodynamics of macromolecular 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. Phase equilimbria, solubility, Phase diagrams, polymer/solvent binary systems, polymeric blends. Dilute polymer solutions and characterization methods of polymers, osmotic pressure-determination of Mn, viscometry-determination of Mv, gel permeation chromatography. Solid state properties of macromolecules Crystallization state, kinetics of crystallization, melting, amorphous state, glass transition temperature, free volume theory. Mechanical properties.			
Recommended literature	1. «Συνθετικά Μακρομόρια, Βασική Θεώρηση», Α.Ντόντος, Εκδ. Κωσταράκης, Αθήνα 2012.			
	2. «Επιστήμη και Τεχνολογία Πολυμερών», Κ. Παναγιώτου, Εκδ. ΠΗΓΑΣΟΣ, Θεσσαλονίκη.			
	3. "Polymer Chemistry" P.C.Hiemenz, T.P. Lodge 2nd Ed. CRC Press, New York 2007.			
Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	3 h/w	1 h/w	N h/w	1/semester
Assessment type	Combined			
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). Final written examination.			
Instruction Language	Greek			
Erasmus availability	YES			
Module URL	https://eclass.upatras.gr/courses/CMNG2154/			
Last Amendment	January 2017			

Technical Thermodynamics and Balances

Module code	**CHM_540**			
Module title	***Technical Thermodynamics and Balances***			
Status	Live	**Type**	Compulsory	
Category A	Core Chemical Engineering		**%**	100%
Category B	Choose Module Category B		**%**	%
Year of study	3	**Semester**	Fall	
ECTS credits	6	**Teaching Units**	4	
Name of lecturers	Dimitris Vayenas - Vlasis Mavrantzas			
Learning outcomes	**CAT**	**Description**		
	A	Apply principles and methods of General Chemistry, Physical Chemistry , Classical Thermodynamics and Calculus in solving Chemical Engineering Problems.		
	C	Ability to create models of any process based on properly chosen control volumes and input/output streams, and to subsequently solve them using the		

Module code	CHM_540	
		corresponding material, energy and entropy balances.
	D	Mastering the use of key chemical engineering concepts, like model formulation and property-balances application thereon, in diverse technological areas.
	G	Ability to appreciate the impact of engineering calculations (and the uncertainties thereof), when applied on problems involving critical economic, environmental and health/safety issues, via selected worked out examples.
Competences Prerequisites	Students are expected to have basic knowledge from Mathematics, General and Inorganic Chemistry, Organic Chemistry as well as Thermodynamics I & II courses.	
Module content	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. Combined Mass, Energy and Entropy balances. Thermodynamic analysis of processes: Entropy balance and reversibility. Heat, work, engines (cycles) and entropy. Available energy, work losses, thermodynamic efficiency. Applications to power generation, liquefaction, refrigeration cycles, and chemical processes.	
Recommended literature	1. D.M.Himmelblau, J.B.Riggs, "Basic Principles and Calculations in Chemical Engineering", 8th Edition, (Transl. in Greek by G. Marnelos), Edit.Tziola (2015)	
	2. 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)	
	3. 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**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	3 h/w	2 h/w	0 h/w	0/semester

Assessment type	Written Examination
Assessment and grading methods	
Instruction Language	Greek
Erasmus availability	NO
Module URL	https://eclass.upatras.gr/courses/CMNG2196/
Last Amendment	December 2016

Materials Science

Module code	**CHM_381**			
Module title	***Materials Science***			
Status	Live	**Type**	Compulsory	
Category A	Core Chemical Engineering		**%**	%
Category B	Choose Module Category B		**%**	%

Module code	**CHM_381**		
Year of study	3	**Semester**	Fall
ECTS credits	6	**Teaching Units**	4
Name of lecturers	Konstantinos Dassios - Stella Kennou		

Learning outcomes	**CAT**	**Description**
	A	Know the fundamental science and engineering principles relevant to materials.
	A	Understand the relationship between nano/microstructure, characterization, properties and processing and design of materials.
	A	Have the fundamental experimental and computational skills as engineers in materials.
	A	To be able to apply general math, science and engineering skills to the solution of engineering problems.
	A	To be able to apply core concepts in Materials Science to solve engineering problems.
	A	To be able to select materials for design and construction.
	D	Possess the skills and techniques necessary for modern materials engineering practice.

Competences Prerequisites	There are no prerequisites for this module. Students should have basic knowledge of mathematics and physics.
Module content	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. 1st and 2nd Fick's laws. Examples. Phase (equilibrium) diagrams Introduction. Phases. Microstructure. Phase equilibria. Isomorphic 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 Electrical 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 Magnetic properties Magnetic fields, Induction, Magnetization, -Induction- Diamagnetism, Paramagnetism, Ferromagnetism, Magnetic materials and applications. Examples Thermal properties Metals, Ceramics and Polymers- Applications. Examples ***Keywords***: Material Science, Material Engineering,

Module code	**CHM_381**			
Recommended literature	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			
Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	3 h/w	2 h/w	0 h/w	0/semester
Assessment type	Written Examination			
Assessment and grading methods				
Instruction Language	Greek			
Erasmus availability	NO			
Module URL	http://www.chemeng.upatras.gr/en/content/courses/en/materials-science			
Last Amendment	January 2017			

Microbiology

Module code	**CHM_680**			
Module title	***Microbiology***			
Status	Live	**Type**	Compulsory	
Category A	Underpinning Mathematics, Science and Associated engineering		**%**	100%
Category B	Choose Module Category B		**%**	%
Year of study	3	**Semester**	Fall	
ECTS credits	4	**Teaching Units**	3	
Name of lecturer	Maria Dimarogona			
Learning outcomes	**CAT**	**Description**		
	A	Ability to use microorganisms to produce products or treat pollutants.		
	B	Ability to identify the basic categories and ability to grow microorganisms.		
	C	Formulation of models for microbial growth, nutrients and pollutants depletion and products production.		
	F	Ability to be involved in developing new biotechnological products.		
	G	Professional use of microorganisms and ethical behavior.		
	I	Ability to cooperate with multidisciplinary teams.		
	K	Ability to prepare and present projects.		
Competences Prerequisites	Basic knowledge in biology is preferable			

Module code	CHM_680			
Module content	Introduction to Microbiology. Historical overview of Microbiology. Major contributions of various individuals who have contributed to the study of microbiology. Cellular Biochemistry. Chemical components of cells. Comparison of the cell components of eukaryons and prokaryons. Structure and functions of the cell components of prokaryons. Prokaryotic Diversity. Principles of classification. Classification system used to identify bacteria. Microscopic observation and identification of bacteria. Methods and techniques used to study and examine microbes. Use of various types of microscopy, stains, and media for study of bacteria. Introduction to bacteria. Bacterial cell structure. Bacterial morphology and physiology. Phylogeny of bacteria. Bacterial Metabolism. Principles of nutrition. Major catabolic and anabolic pathways. Regulation of metabolism. Microbial Growth and Reproduction. Growth of bacterial populations. Control of bacterial growth and factors that influence it. Enzyme structure, function and regulation. endospore formation. Viruses and disease. Virus structure and replication mechanisms. Specific viral pathogens, disease, treatment and protection. Morphology and growth of fungi. Morphology and growth of yeasts. Morphology and growth of algae. Use of aseptic technique, culturing techniques, and stains. Observe and interpret experimental results. Topics in Applied Microbiology. Examples: food microbiology, industrial microbiology, environmental bioremediation.			
Recommended literature	1. Μικροβιολογία και μικροβιακή τεχνολογία, Αγγελής Γ., Εκδόσεις Σταμούλη Α.Ε, 2007			
	2. Βιολογία των μικροοργανισμών, Τόμος Ι, Madigan M.T, Παν. Εκδόσεις Κρήτης, 2008.			
Teaching and learning methods	LECTURES	RECITATION	LAB/PRACTICE	PROJECT / HOMEWORK
	3 h/w	0 h/w	0 h/w	1/semester
Assessment type	Combined			
Assessment and grading methods	Written examination counts for 60% while the project counts for 40% of the final grade			
Instruction Language	Greek			
Erasmus availability	YES			
Module URL	https://eclass.upatras.gr/courses/CMNG2184/			
Last Amendment	December 2016			

Materials Laboratory

Module code	CHM_481			
Module title	***Material Laboratory***			
Status	Live	Type	Compulsory	
Category A	Chemical Engineering Practice		%	100%
Category B	Choose Module Category B		%	%
Year of study	3	Semester	Fall	
ECTS credits	3	Teaching Units	2	
Name of lecturer	Angeliki Christogerou			
Learning outcomes	CAT	Description		
	A	Understanding of the principles and procedures which concern: -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		

<table>
<tr><td>Module code</td><td colspan="4">CHM_481</td></tr>
<tr><td></td><td></td><td colspan="3">-Thermal analysis of metals and their alloys
-Construction of phase diagrams using experimental data</td></tr>
<tr><td></td><td>B</td><td colspan="3">Ability to:
-combine theoretical fundamentals (from the module “Materials Science”) with 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</td></tr>
<tr><td></td><td>B</td><td colspan="3">Ability to use equipment and tools for sample preparation (cutting devices, hydraulic mounting press, polishing, etching, laboratory muffle furnaces, temperature measurement devices) as well as to use optical devices (microscopes, stereoscopes)</td></tr>
<tr><td></td><td>K</td><td colspan="3">Ability to cooperate with others and to present and discuss results within a group</td></tr>
<tr><td>Competences Prerequisites</td><td colspan="4">There are no prerequisite modules. The students should have a basic knowledge of Material Science I.</td></tr>
<tr><td>Module content</td><td colspan="4">– 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).</td></tr>
<tr><td rowspan="4">Recommended literature</td><td colspan="4">1. Instructor’s notes</td></tr>
<tr><td colspan="4">2. “Μεταλλογνωσία” (Κράματα, Μέταλλα, Βιομηχανικά Κράματα), Κ. Κονοφάγος</td></tr>
<tr><td colspan="4">3. “Εισαγωγή στην Επιστήμη των Υλικών- Μεταλλογνωσία”, Π. Νικολόπουλος.</td></tr>
<tr><td colspan="4">4. “Materials Science and Engineering: An Introduction” William D. Callister.</td></tr>
<tr><td rowspan="2">Teaching and learning methods</td><td>LECTURES</td><td>RECITATION</td><td>LAB/PRACTICE</td><td>PROJECT / HOMEWORK</td></tr>
<tr><td>0 h/w</td><td>0 h/w</td><td>4 h/w</td><td>0/semester</td></tr>
<tr><td>Assessment type</td><td colspan="4">Combined</td></tr>
<tr><td>Assessment and grading methods</td><td colspan="4">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).</td></tr>
<tr><td>Instruction Language</td><td colspan="4">Greek</td></tr>
<tr><td>Erasmus availability</td><td colspan="4">NO</td></tr>
<tr><td>Module URL</td><td colspan="4">https://eclass.upatras.gr/courses/CMNG2156/</td></tr>
<tr><td>Last Amendment</td><td colspan="4">January 2017</td></tr>
</table>

3.7 3rd Year – 6th Semester

Heat Transfer

Module code	**CHM_650**			
Module title	***Heat Transfer***			
Status	Live	**Type**	Compulsory	
Category A	Core Chemical Engineering		**%**	100%
Category B	Choose Module Category B		**%**	%
Year of study	3	**Semester**	Spring	
ECTS credits	6	**Teaching Units**	4	
Name of lecturer	John Tsamopoulos			

Learning outcomes	**CAT**	**Description**
	A	The ability to 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. The ability to develop microscopic and macroscopic heat transfer balances in steady and transient state.
	C	Understand how to simplify practical and complicated heat transfer problems and solve them primarily analytically, but also by using appropriate numerical methods
	D	Understand how 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. 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.

Competences Prerequisites	CHM_102, CHM_201, CHM_300, CHM_402, CHM_130, CHM_230, CHM_220, CHM_320, CHM_550
Module content	INTRODUCTION. Mechanisms of heat transfer, examples. Fourier's law for heat conduction, Newton correlation in heat convection. General differential equation for heat transfer. Boundary and initial conditions in heat transfer problems. The Biot number. STEADY 1D HEAT CONDUCTION. Heat generation in the bulk and on material interfaces. Addition of heat resistances in various geometries. The fin approximation. STEADY HEAT CONDUCTION IN 2D. Exact solutions via separation of variables. Shape factor. Solution using charts and polynomial approximations. TRANSIENT HEAT CONDUCTION IN ONE OR MORE DIMENSIONS. The similarity method. Solution using separation of variables. Approximate solutions. INTRODUCTION TO HEAT CONVECTION. Forced and free convection. Dimensionless analysis and similarity. Examples admitting simple analytical solution. Approximate correlations in heat convection. Analogies between heat, mass and momentum transfer. 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 hydraulic and heat characteristics. Using polynomials to obtain approximate solutions. Correlations and 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 RADIATION. Radiation intensity. Radiation formula by PLANCK. Law by STEFAN-BOLTZMANN. Radiation and absorption. The black and brown body. Radiation between brown bodies. Gas radiation.
Recommended literature	1. Μεταφορά Θερμότητας και Μάζας, Ασημακόπουλος, Λυγερού, Αραμπατζής, Παπασωτηρίου

Module code	CHM_650			
	2. Αρχές Μεταφοράς Θερμότητας και Μάζας, Κακάτσιος, Συμεών			
	3. Fundamentals of Transport Phenomena, Fahien, McGraw Hill			
Teaching and learning methods	LECTURES	RECITATION	LAB/PRACTICE	PROJECT / HOMEWORK
	3 h/w	2 h/w	0 h/w	26/semester
Assessment type	Written Examination			
Assessment and grading methods	A final exam is given in the end of the sementer. It covers the most important topics of the module via two or three problems, which have prespecified weights. The exam is graded by the Lecturer. In the past an optional mid-term exam was given, but less than 25% of the students participated.			
Instruction Language	Greek			
Erasmus availability	YES			
Module URL	https://eclass.upatras.gr/courses/CMNG2203/			
Last Amendment	January 2017			

Mass Transfer

Module code	CHM_755			
Module title	***Mass Transfer***			
Status	**Live**	**Type**	Compulsory	
Category A	Core Chemical Engineering		**%**	100%
Category B	Choose Module Category B		**%**	%
Year of study	3	**Semester**	Spring	
ECTS credits	4	**Teaching Units**	3	
Name of lecturer	Ioannis Kookos			
Learning outcomes	**CAT**	**Description**		
	A	Ability to calculate diffusion coefficients in various systems		
	C	Formulation of diffusion and convective mass transfer models		
	D	Diffusion problems in various applications including unit operations such as evaporation, distillation, absorption		
	E	Ability to design chemical processes involving mass transfer		
Competences Prerequisites	The students are advised to refresh their knowledge in mass and energy balances, as well as in transport phenomena			
Module content	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			

Module code	**CHM_755**			
	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 AND POLLUTION IN WATER RESOURCES: STREETER-PHELPS EQUATIONS			
Recommended literature	1. ΛΥΓΕΡΟΥ ΒΑΣΙΛΙΚΗ, ΑΣΗΜΑΚΟΠΟΥΛΟΣ ΔΙΟΝΥΣΗΣ, ΑΡΑΜΠΑΤΖΗΣ ΓΕΩΡΓΙΟΣ, "ΜΕΤΑΦΟΡΑ ΜΑΖΑΣ", Εκδόσεις Α.ΠΑΠΑΣΩΤΗΡΙΟΥ & ΣΙΑ ΟΕ, ΑΘΗΝΑ, 2005			
	2. Transport Phenomena: A Unified Approach, Brodkey & Hershey, McGraw-Hill			
Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	2 h/w	1 h/w	0 h/w	0/semester
Assessment type	Written Examination			
Assessment and grading methods	There is a final examination accounting for 100% of the mark			
Instruction Language	Greek			
Erasmus availability	NO			
Module URL	https://eclass.upatras.gr/courses/CMNG2169/			
Last Amendment	January 2017			

Instrumental Chemical Analysis

Module code	**CHM_515**			
Module title	***Instrumental Chemical Analysis***			
Status	**Live**	**Type**	Compulsory	
Category A	Underpinning Mathematics, Science and Associated engineering		**%**	100%
Category B	Choose Module Category B		**%**	%
Year of study	3	**Semester**	Spring	
ECTS credits	4	**Teaching Units**	3	
Name of lecturers	Georgios Kyriakou			
Learning outcomes	**CAT**	**Description**		
	A	Basic knowledge of the instrumentation and applications of chromatography, spectroscopy and electroanalytical chemistry in chemical analysis.		
	B	Familiarization with different types of analytical methods, analytical instrumentation and calibration methodology.		
	B	Ability to choose and implement an instrumental method of analysis depending on the application and analysis needed.		
Competences Prerequisites	General and Inorganic Chemistry (CHM_110), Analytical Chemistry (CHM_115)			
Module content	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. Introduction to Electrochemistry and Electroanalytic chemistry, Potentiometry, Electrogravimetry and Coulometry, Voltammetry.			

Module code	**CHM_515**			
Recommended literature	1. ΄΄Principles of Instrumental Analysis΄΄ Skoog, Holler, Nieman, Kostarakis Editions (ISBN 978-960-87655-7-3)			
	2. ΄΄Modern techniques in chemical analysis΄΄ Pecsok, Shields, Cairns, McWilliam, Pnevmatikos EditionsΕκδόσεις (ISBN: 960-7258-27-4)			
Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	3 h/w	1 h/w	0 h/w	0/semester
Assessment type[9]	Combined			
Assessment and grading methods	1. Problem solving (homework assignment) by the students every week (up to 2 units bonus, which are added to the final mark, provided it is > 5) 2. Final written exam			
Instruction Language	Greek			
Erasmus availability	NO			
Module URL	https://eclass.upatras.gr/courses/CMNG2142/			
Last Amendment	January 2017			

Chemical Reaction Engineering I

Module code	**CHM_741**			
Module title	***Chemical Reaction Engineering I***			
Status	**Live**	**Type**	Compulsory	
Category A	Core Chemical Engineering		**%**	100%
Category B	Choose Module Category B		**%**	%
Year of study	3	**Semester**	Spring	
ECTS credits	6	**Teaching Units**	6	
Name of lecturer	Alexandros Katsaounis			
Learning outcomes	**CAT**	**Description**		
	A	Compute adiabatic temperatures and chemical equilibrium compositions.		
	B	Understand the principles of chemical kinetics.		
	C	Describe in detail the operation and design of the main types of ideal chemical reactors.		
	D	Describe the main types of non-ideal chemical reactors.		
Competences Prerequisites	General and Inorganic Chemistry Introduction to Chemical Engineering (CHM_110), Analytical Chemistry Introduction to Chemical Engineering (CHM_140), Chemical Thermodynamics I & II (CHM_220, CHM_320)			
Module content	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.			
Recommended literature	1. C.G. Vayenas, "Analysis and Design of Chemical Reactors", Patras University Press (1986), in Greek			
	2. H. Scott Fogler, "Elements of Chemical Reaction Engineering", Prentice-Hall International, Inc. (1986).			
	3. X.E. Verykios, "Chemical Reaction Kinetics and Design of Chemical Reactors", University of Patras Press, Patras (1992), in Greek			

Module code	CHM_741			
Teaching and learning methods	LECTURES	RECITATION	LAB/PRACTICE	PROJECT / HOMEWORK
	3 h/w	1 h/w	0 h/w	0/semester
Assessment type	Combined			
Assessment and grading methods	In class and take-home exercises (20%) Progress exam (40%) Final exam (40%)			
Instruction Language	Greek			
Erasmus availability	NO			
Module URL	http://www.chemeng.upatras.gr/en/content/courses/en/chemical-reaction-engineering-i			
Last Amendment	January 2017			

Process Dynamics & Control

Module code	CHM_840			
Module title	*Process Dynamics & Control*			
Status	Live	Type	Compulsory	
Category A	Core Chemical Engineering		%	70%
Category B	Chemical Engineering Practice		%	30%
Year of study	3	Semester	Spring	
ECTS credits	7	Teaching Units	5	
Name of lecturers	Michael Kornaros, Stavros Pavlou			
Learning outcomes	CAT	Description		
	A	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.		
	B	Use and simplify block diagrams		
	B	Construct and interpret Bode diagrams and root locus diagrams		
	B	Understand the significance of controller actions (proportional, integral, derivative).		
	A	Apply methods of optimal tuning of PID controllers		
Competences Prerequisites	There are no prerequisite modules. Students should have some basic knowledge of differential equations and mass and energy balances			
Module content	DYNAMIC RESPONSE OF PHYSICAL SYSTEMS. First-order systems. Conn ections 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			

Module code	CHM_840			
	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.			
Recommended literature	1. N. Krikelis, "Introduction to Automatic Control", Athens technical University Editions			
	2. R. C. Dorf and R. H. Bishop, "Modern Control Systems", Prentice Hall			
	3. Νταουτίδης Π., Μαστρογεωργόπουλος Σ., Παπαδοπούλου Σ., "Έλεγχος Διεργασιών", Εκδ. Τζιόλα			
Teaching and learning methods	LECTURES	RECITATION	LAB/PRACTICE	PROJECT / HOMEWORK
	3 h/w	2 h/w	1 h/w	0/semester
Assessment type	Combined			
Assessment and grading methods	1. Written lab reports (15% of the final mark). 2. Written examination (85% of the final mark)			
Instruction Language	Greek			
Erasmus availability	NO			
Module URL	https://eclass.upatras.gr/modules/auth/opencourses.php?fc=59			
Last Amendment	December 2016			

Polymers Laboratory

Module code	CHM_671			
Module title	***Polymers Laboratory***			
Status	Live	Type	Compulsory	
Category A	Chemical Engineering Practice		%	100%
Category B	Choose Module Category B		%	%
Year of study	3	Semester	Spring	
ECTS credits	3	Teaching Units	2	
Name of lecturer	Konstantinos Dassios – George Pasparakis			
Learning outcomes	CAT[5]	Description		
	B	Ability to organize and perform experiments using instrumental analytical techniques for the characterization of polymers and determination of their properties.		
	B	Be acquainted with the basic knowledge of these techniques and process the data of the experiments.		
	F	To evaluate the result and understand the polymers' properties from both laboratory experiments and "Polymer Science" module.		
Competences Prerequisites	Students should have basic knowledge of Polymer Science and Instrumental Analysis.			

Module code	**CHM_671**			
Module content	*Viscometry*: determination of intrinsic viscosity, average molecular weight Mv and molecular size of macromolecules by using Ubbelohde viscometers. *Gel permeation chromatography (GPC):* determination of average molecular weights and molecular weight distribution of polymers. *Infrared spectroscopy (FTIR):* application of FTIR for the identification of polymers and determination of copolymer composition. *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). *Differential scanning calorimetry (DSC):* determination of glass transition temperature, degree of crystallization and melting temperature of polymeric samples. *Tensile Testing:* stress-strain curves of various polymeric samples and determination of mechanical ultimate properties. *Polymer Rheology:* study of the rheological behavior of concentrated aqueous polymer solutions by using Couete viscometer, effect of Mw and temperature.			
Recommended literature	1. "Εργαστήριο Πολυμερών" Σημειώσεις, Κ. Τσιτσιλιάνης, Ο. Κούλη Φεβρουάριος 2013			
	2. Experiments in Polymer Science, E.A. Collins, J. Bares, F.W. Billmeyer, Jr. Wiley, New York, 1973			
Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	0 h/w	0 h/w	4 h/w	N/semester
Assessment type	Combined			
Assessment and grading methods	Multiple choise test, before practice (25%), Report with the results (25%), Final writing examination (50%).			
Instruction Language	Greek			
Erasmus availability	YES			
Module URL	https://eclass.upatras.gr/courses/CMNG2158/			
Last Amendment	January 2017			

3.8 4th Year - 7th Semester

Unit Operations I

Module code	**CHM_655**			
Module title[2]	***Unit Operations I***			
Status	Live	**Type**	Compulsory	
Category A	Core Chemical Engineering		**%**	70%
Category B	Chemical Engineering Design Practice and Design Projects		**%**	30%
Year of study	4	**Semester**	Fall	
ECTS credits	6	**Teaching Units**	4	
Name of lecturer	Christakis Paraskeva			
Learning outcomes	**CAT**	**Description**		
	A	Students are trained in basic separation processes (Distillation, absorption, membranes, fixed and fluidized beds, etc)		
	B	Students learn to apply theory, experimental methodology, data analysis and interpretation		
	E	Students learn design unit operation processes with the aid of a process simulation software		
	I	Students learn to work and co-operate in multidisciplinary teams to present their results in original reports		
Competences Prerequisites	To attend the module 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 module 'Mass and Energy Balances'			
Module content	Unit operation I 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 adsorption processes. Evaporation, drying and extraction. Fixed and Fluidized Beds: Conditions for fluidization. Gas-solid systems. Membrane filtration (macrofiltration, Ultrafiltration, Nanofiltration, reverse osmosis): Separation mechanism, membrane materials, membrane configuration, synthesis, applications, etc Process simulation software packages in Chemical Engineering. Project for the complete design of a distilled column for the separation of a binary liquid mixture.			
Recommended literature	1. ΙΩΑΝΝΗΣ ΓΕΝΤΕΚΑΚΗΣ, "ΦΥΣΙΚΕΣ ΔΙΕΡΓΑΣΙΕΣ'', ΕΚΔΟΣΕΙΣ ΚΛΕΙΔΑΡΙΘΜΟΣ Ε.Π.Ε., ΑΘΗΝΑ, 2010			
	2. McCABE WARREN, SMITH JULIAN C., HARRIOTT PETER "ΒΑΣΙΚΕΣ ΔΙΕΡΓΑΣΙΕΣ ΧΗΜΙΚΗΣ ΜΗΧΑΝΙΚΗΣ, ΕΚΔΟΣΕΙΣ Α.ΤΖΙΟΛΑ & ΥΙΟΙ Ο.Ε., ΘΕΣ/ΝΙΚΗ, 2002			
	3. ΑΣΣΑΕΛ ΜΑΡΚΟΣ Ι., ΜΑΓΓΙΛΙΩΤΟΥ ΜΑΡΙΑ Χ., "ΦΥΣΙΚΕΣ ΔΙΕΡΓΑΣΙΕΣ", ΕΚΔΟΣΕΙΣ Α.ΤΖΙΟΛΑ & ΥΙΟΙ Ο.Ε., ΘΕΣ/ΝΙΚΗ, 2009			
Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	2 h/w	2 h/w	2 h/w	2/semester

Module code	**CHM_655**
Assessment type	Combined
Assessment and grading methods	(Final exam) x 0.7 + 0.1 x Project + (laboratory grade) x 0.2 = Final Grade
Instruction Language	Greek
Erasmus availability	YES
Module URL	http://www.chemeng.upatras.gr/en/content/courses/en/unit-operations-i
Last Amendment	December 2016

Biochemical Process Engineering

Module code	**CHM_742**			
Module title	***Biochemical Process Engineering***			
Status	Live	**Type**	Compulsory	
Category A	Core Chemical Engineering		**%**	100%
Category B	Choose Module Category B		**%**	%
Year of study	4	**Semester**	Fall	
ECTS credits	6	**Teaching Units**	5	
Name of lecturer	Maria Dimarogona			
Learning outcomes	**CAT**	**Description**		
	A	Ability to apply principles of biology to derive energetics and stoichiometries in biological reactions		
	B	Data analysis and interpretation in enzymatic and biological reactions		
	C	Use and understanding of kinetic models in biochemical engineering		
	D	Understanding the role of biochemical enginnering in technological fields such as pharmaceuticals and waste treatment		
	E	Design of various types of bioreactors		
Competences Prerequisites	The students should refresh their knowledge in Microbiology			
Module content	Basics of microbiology, biochemistry and genetics. Biochemical reaction stoichiometry, mass balances and energetics of half reactions. Enzyme kinetics. The Michaelis-Menten and Briggs-Haldane models. Determination of kinetic parameters. Factors affecting enzymatic reactions (multiple substrates, co-enzymes, pH, temperature, reversible reactions). Enzyme inhibition (competitive, non-competitive, uncompetitive) and deactivation. Immobilized enzymes (mass transfer limitations, Thiele modulus, effectiveness factor). Kinetics of microbial growth, substrate utilization and metabolic product generation. The Monod model and comparison of various kinetic models. Factors affecting microbial growth. Sterilization and disinfection. Bioreactor types (batch, fed-batch, CSTR). Bioreactor design and productivity optimization. Sequence of bioreactors. Biofilms (the ideal biofilm, biofilm models). Bioseparations and down-stream processing (sedimentation, filtration, centrifugation, liquid-liquid extraction, chromatographic separations, electrophoresis, membranes, crystallization, drying).			
Recommended literature	1. Εισαγωγή στη Βιοχημική Μηχανική, Λυμπεράτου & Παύλου, Εκδόσεις Τζιόλα			
	2. Bioprocess Engineering, Shuler & Kargi, Prentice-Hall			
	3. Biochemical Engineering Fundamentals, Bailey & Ollis, 2nd edition, McGraw-Hill			

Module code	CHM_742			
Teaching and learning methods	LECTURES	RECITATION	LAB/PRACTICE	PROJECT / HOMEWORK
	3 h/w	2 h/w	0 h/w	0/semester
Assessment type	Written Examination			
Assessment and grading methods	There is a final examination accounting for 100% of the mark			
Instruction Language	Greek			
Erasmus availability	YES			
Module URL	https://eclass.upatras.gr/courses/CMNG2182/			
Last Amendment	January 2017			

Process and Plant Design

Module code	CHM_941			
Module title	*Process and Plant Design*			
Status	Live	Type	Compulsory	
Category A	Chemical Engineering Design Practice and Design Projects		%	70%
Category B	Adv. Chem. Engineering (Design)		%	30%
Year of study	4	Semester	Fall	
ECTS credits	6	Teaching Units	5	
Name of lecturer	Ioannis Kookos			
Learning outcomes	CAT	Description		
	B	Ability to collect thermodynamic data and select appropriate thermodynamic models.		
	A	Ability to develop strategies for process systems simulation		
	C	Ability to use computer-based flowsheeting and numerical simulation tools to support process design activities		
	K	Ability to develop strategies for performing chemical process unit design.		
Competences Prerequisites	Material and Energy Balances, Thermodynamics, Transport Phenomena			
Module content[7]	The following issues are addressed: The difficulties encountered when simulating complex mixtures are analyzed and the basic elements of chemical engineering thermodynamics are reviewed. Thermodynamic models such as cubic EOS and activity models are critically reviewed. Ideal and non-ideal mixtures and solutions are reviewed and the corresponding thermodynamic models are presented. The estimation of thermo-physical properties using group contribution methods, such as the method Joback, are presented. The implementation of thermodynamic models into computer software and the use of pseudo-components are discussed. The methods available for structuring process systems calculations, in order to take advantage of the sparse structure of the relevant equations, are analyzed and their implementation in the most commonly used commercial simulation tools is discussed. Recycle streams and their implications to the solution of the material and energy balances for complete plants are discussed. Examples of the efficient steady-state simulation of complete process flow diagrams are presented in the classroom. The underlying principles for the design and sizing of main process units, such as distillation columns, heat exchangers, phase separation units, mixing tanks and reactors, pumps and compressors are analyzed in detail and the available methodologies are extended to non-conventional units.			

Module code	**CHM_941**			
Recommended literature	1. I.K.KOOKOS, Analysis of Chemical Processes, Tziola Publishing, 2011, in Greek			
	2. I.K.KOOKOS, Chemical Process Design, Tziola Publishing, 2007, in Greek			
	3. Perry's Chemical Engineers Handbook, McGraw Hill, Available in electronic document in University Library			
Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	4h/w	1 h/w	0 h/w	1/semester
Assessment type	Combined			
Assessment and grading methods	Final exam, weekly projects.			
Instruction Language	Greek			
Erasmus availability	NO			
Module URL	https://eclass.upatras.gr/courses/CMNG2171/			
Last Amendment	December 2016			

Chemical Engineering Processes Laboratory I

Module code	**CHM_756**			
Module title	***Chemical Engineering Processes Laboratory I***			
Status	Live	**Type**	Compulsory	
Category A	Chemical Engineering Practice		**%**	100%
Category B	Choose Module Category B		**%**	%
Year of study	4	**Semester**	Fall	
ECTS credits	3	**Teaching Units**	2	
Name of lecturers	Dimitris Vayenas - Christakis Paraskeva			
Learning outcomes	**CAT**	**Description**		
	A	Students are trained in basic chemical engineering processes.		
	B	Students learn to operate experimental laboratory or semi-pilot devices and present their results in original technical reports.		
	D	Students exploit the knowledge gained in their respective theoretical modules.		
Competences Prerequisites	There are no formal prerequisite modules. Basic knowledge by the following modules is necessary: Fluid Flow, Unit Operations, Mass Transfer, Chemical Process and Chemical Reactor Design, Mass and Energy Balances.			
Module content[7]	The Chemical Engineering Processes Laboratory I contains seven exercises, four refer Unit Operations (Instructor C. Paraskeva) and three to Chemical Processes (Instructor D. Spartinos). The exercises are performed by groups of 4-5 students: The exercises of Unit Operations are: ***1. Gas Absorption*** Adsorption of $CO2$ in a packed bed absorption tower. ***2. Solid and fluidized bed*** Experimental estimation of porosity, permeability, mean grain diameter, specific area, friction coefficient, minimum and maximum (terminal) velocities in fluidized beds. ***3. Drag coefficient and viscosity*** Experimental estimation of drag force on a spherical particle and of the liquid viscosity. ***4. Diffusion of liquids and gases*** Experimental estimation of diffusion coefficient in gases (Arnold Cell) and in liquids.			

	(Winkleman method). The exercises of Chemical Processes are: ***1. Study of Chemical Reaction Kinetics in Gas Chromatography*** Kinetics of acetic methyl ester hydrolysis and quantitative and qualitative analysis of byproducts in gas chromatographer. ***2. Residence time distribution in a stirred reactor*** Experimental estimation of the residence time distribution function(E) and the percentage of the molecules with residence time less than time (t). 3. ***Catalytic Oxidation of Ethylene*** Catalytic oxidation of ethylene using catalysts as Pt, Pd, and Rh.
Recommended literature	ΠΑΡΑΣΚΕΥΑ Χ. -ΣΠΑΡΤΙΝΟΣ Δ., "ΣΗΜΕΙΩΣΕΙΣ ΕΡΓΑΣΤΗΡΙΟΥ ΔΙΕΡΓΑΣΙΩΝ Ι", Εκδόσεις Πανεπιστημίου Πατρών, 2012, ΠΑΤΡΑ

Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	N h/w	N h/w	4 h/w	7/semester

Assessment type	Combined
Assessment and grading methods	The evaluation of the exercises of Unit Operations is as follows: 1. Written examination, after running all 4 exercises (theory and simple exercises) (50%), 2. Marking of the final report (50%). The evaluation of Chemical Processes exercises is as follows: 1. 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 module.
Instruction Language	Greek
Erasmus availability	NO
Module URL	http://www.chemeng.upatras.gr/en/content/courses/en/chemical-engineering-processes-laboratory-i
Last Amendment	December 2016

Chemical Reaction Engineering II

Module code	**CHM_841**		
Module title	***Chemical Reaction Engineering II***		
Status	Live	**Type**	Compulsory
Category A	Core Chemical Engineering	**%**	100%
Category B	Choose Module Category B	**%**	%
Year of study	4	**Semester**	Fall
ECTS credits	6	**Teaching Units**	4
Name of lecturer	Symeon Bebelis – Georgios Kyriakou		

Learning outcomes	**CAT**	**Description**
	D	A good understanding of the basic principles and applications of heterogeneous catalysis and of the structure of solid catalysts.
	D	A good understanding of the concept of the intrinsic rate of catalytic reactions and of the concept of the global (overall) rate.
	A	Ability to develop the intrinsic rate of catalytic reactions through their mechanism and to test it with experimental data.
	A	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.

Module code	**CHM_841**	
	C	Familiarization with the different models of simulation of catalytic reactors and their basic assumptions
Competences Prerequisites	Chemical Reaction Engineering I	
Module content	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.	
Recommended literature	1. X. E. Verykios, " Heterogeneous Catalytic Reactions and Reactors", Kostarakis Publications, Athens 2004 (in Greek)	
	2. M. Smith, "Chemical Engineering Kinetics", McGraw-Hill, New York 1981.	

Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	3 h/w	2 h/w	0 h/w	0/semester
Assessment type	Combined			
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			
Instruction Language	Greek			
Erasmus availability	NO			
Module URL	https://eclass.upatras.gr/courses/CMNG2186/			
Last Amendment	January 2017			

Production and Project Management

Module code	**CHM_795**			
Module title	***Production and Project Management***			
Status	Live	**Type**	Elective	
Category A	Management & Economics		**%**	100%
Year of study	4	**Semester**	Fall	
ECTS credits	3	**Teaching Units**	3	
Name of lecturer(s)	Department of Mechanical Engineering & Aeronautics			

Introduction to Business Administration

Module code	**CHM_796**			
Module title	***Introduction to Business Administration***			
Status	Live	**Type**	Elective	
Category A	Management & Economics		**%**	100%
Year of study	4	**Semester**	Fall	
ECTS credits	3	**Teaching Units**	3	
Name of lecturer(s)	Department of Mechanical Engineering & Aeronautics			

General Ecology

Module code	**CHM_798**			
Module title	***General Ecology***			
Status	Live	**Type**	Elective	
Category A	Underpinning Mathematics, Science and Associated engineering		**%**	100%
Year of study	4	**Semester**	Fall	
ECTS credits	3	**Teaching Units**	3	
Name of lecturer(s)	Department of Biology			

Operational Research

Module code	**CHM_799**			
Module title	***Operational Research***			
Status	Live	**Type**	Elective	
Category A	Management & Economics		**%**	100%
Year of study	4	**Semester**	Fall	
ECTS credits	3	**Teaching Units**	3	
Name of lecturer(s)	Department of Business Administration			

Introduction to Economics for Engineers and Scientists

Module code	**CHM_780**			
Module title	***Introduction to Economics for Engineers and Scientist***			
Status	Live	**Type**	Elective	
Category A	Management & Economics		**%**	100%
Year of study	1	**Semester**	Fall	
ECTS credits	3	**Teaching Units**	3	
Name of lecturer(s)	Department of Economics			

Introduction to Business Administration for Engineers and Scientists

Module code	**CHM_797**			
Module title	***Technical Project Management***			
Status	Suspended	**Type**	Elective	
Category A	Management & Economics		**%**	100%
Year of study	1	**Semester**	Fall	
ECTS credits	3	**Teaching Units**	3	
Name of lecturer(s)	Department of Business Administration			

3.9 4th Year – 8th Semester

Plant Design and Economics Laboratory

Module code	**CHM_1041**			
Module title	***Plant Design Laboratory***			
Status	Live	**Type**	Compulsory	
Category A	Chemical Engineering Design Practice and Design Projects		**%**	60%
Category B	Adv. Chem. Engineering (Design)		**%**	40%
Year of study	4	**Semester**	Spring	
ECTS credits	10	**Teaching Units**	6	
Name of lecturers	I. Kookos, E. Amanatides, D. Vayenas, M. Dimarogona, A. Katsaounis, G. Kyriakou, M. Kornaros, D. Mantzavinos			
Learning outcomes	**CAT**	**Description**		
	A	Ability to search the literature in order to propose different design options and use of qualitative and quantitative assessment criteria for their evaluation		
	A	Ability to understand and resolve conflicting performance criteria		
	G	Ability to study and apply detailed design procedures for key process units		
	H	Ability to use preliminary HAZOP analysis to identify safety procedures		
	I	Ability to demonstrate proficiency in modelling and simulation of process plants using commercial software		
	J	Ability to prepare and present technical reports		
	K	Ability to. manage a large scale project and working relationships within a large team effectively		
Competences Prerequisites	Plant Design, Thermodynamics, Separtion Processes, ReactionEngineering			
Module content	Students work in groups of 4-6 students. Each group is asked to develop a complete design that includes: • **Process technology selection** The students collect information relative to alternative process technologies for producing the targeted product and use qualitative and quantitative criteria in order to propose a preliminary process flow diagram (PFD). • **Process simulation and energy and process integration** The PFD is simulated in a commercial simulator in order to construct detailed material and energy balances. The simulation is then followed by heat and process integration with the aim to simplify the PFD and to minimize energy consumption. • **Detailed design of Key Process Units** Key process units are identified based on economic, safety and environmental performance criteria and groups are expected to develop detailed design for these units. Some of these units are new to the students (self-learning). • **HAZOP analysis** Having established a preliminary PFD the groups are expected to identify key process units for safety review. The groups are performing HAZOP analysis with the aim to propose appropriate hazard and risk management procedures. • **Techno-economic analysis and technical report preparation** Using the final PDF a detailed techno-economic evaluation is performed and a technical report is prepared and defended orally to a panel of academics. The potential Environmental Impact of the process in evaluated and an Life Cycle Inventory (LCI) is included in the report.			
Recommended	1. I.K.KOOKOS, Analysis of Chemical Processes, Tziola Publishing, 2011, in Greek			

Module code	**CHM_1041**			
literature	2. I.K.KOOKOS, Chemical Process Design, Tziola Publishing, 2007, in Greek			
	3. Perry's Chemical Engineers Handbook, McGraw Hill, Available in electronic document in University Library			
Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	4 h/w	0 h/w	6 h/w	1/semester
Assessment type	Combined			
Assessment and grading methods	Weekly Team and Individual student assessment, oral presentation, technical report.			
Instruction Language	Greek			
Erasmus availability	NO			
Module URL	https://eclass.upatras.gr/courses/CMNG2166/			
Last Amendment	December 2016			

Chemical Engineering Processes Laboratory II

Module code	**CHM_846**			
Module title	***Chemical Engineering Processes Laboratory II***			
Status	Live	**Type**	Compulsory	
Category A	Chemical Engineering Practice		**%**	100%
Category B	Choose Module Category B		**%**	%
Year of study	4	**Semester**	Spring	
ECTS credits	3	**Teaching Units**	2	
Name of lecturerσ	Konstantinos Dassios – Maria Dimarogona			
Learning outcomes	**CAT**	**Description**		
	A	Students are trained in basic chemical and biochemical engineering processes.		
	B	Students learn to operate experimental laboratory or semi-pilot devices and present their results in original technical reports.		
	D	Students exploit the knowledge gained in their respective theoretical modules.		
	I	Students learn to work and co-operate in multidisciplinary teams to present their results in original technical reports		
Competences Prerequisites	There are no formal prerequisite modules. Basic knowledge by the following modules is necessary: Fluid Flow, Heat Transfer, Unit Operations, and Biochemical Process Engineering			
Module content	*Laboratory exercises based on Unit Operations*: 1. Flow in a network of pipelines Calculation of pressure drop values in a network of tubes, calculation of flowrates and fiction losses based on the Poiseuille equation 2. Heat exchanger Energy balances, conduct surfaces, overall heat coefficient, etc The students learn to design complicated systems of flow in networks of pipelines (pressures, flowrates, geometrical characteristics, friction losses) and to design heat exchangers for the heating or cooling of liquid streams *Laboratory exercises based on Biochemical Processes:* 3. Measurement of chemical oxygen demand (COD) Estimation of the organic load in a sample of wastewater. The method is based on complete catalytic chemical oxidation of the organic compounds contained in a wastewater sample.			

Module code	**CHM_846**			
	4. Measurement of biochemical oxygen demand (BOD) Estimation of the organic content that can be degraded biologically (by microorganisms) in a sample of wastewater 5. Microbial growth Growth stages of a microbial culture and procedure to be followed for the estimation of kinetic parameters of growth The students learn the concept of Chemical Oxygen Demand and Biochemical Oxygen Demand as measurements of the organic content of a wastewater sample and have a greater understanding of the microbial growth rates			
Recommended literature	1. ΠΑΡΑΣΚΕΥΑ Χ. - ΚΟΡΝΑΡΟΣ Μ. "ΣΗΜΕΙΩΣΕΙΣ ΕΡΓΑΣΤΗΡΙΟΥ ΔΙΕΡΓΑΣΙΩΝ ΙΙ", Εκδόσεις Πανεπιστημίου Πατρών, 2012, ΠΑΤΡΑ			
	2. "Μηχανική Υγρών Αποβλήτων. Επεξεργασία και Επαναχρησιμοποίηση - Τόμος Α" 4η Έκδοση, Metcalf & Eddy, Εκδ. Τζιόλα, 2006, Θεσ/νίκη. ISBN: 960-148-109-2			
	3. "Διαχείριση Υγρών Αποβλήτων", Γ. Λυμπεράτος και Δ. Βαγενάς, Εκδ. Τζιόλα, 2011, Θεσ/νίκη. ISBN: 978-960-418-346-3			
Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	0 h/w	0 h/w	4 h/w	5/semester
Assessment type	Combined			
Assessment and grading methods	The evaluation of the exercises of Unit Operations is as follows: The evaluation of Unit Operatiosn is as follows: 1. Written examination, after running the 2 exercises (theory and simple exercises) (50%), 2. Marking of the final report (50%). The evaluation of Biochemical Processes exercises 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 (50% of the final mark) In the end, the average of the five exercises summed and averaged out the module.			
Instruction Language	Greek			
Erasmus availability	NO			
Module URL	http://www.chemeng.upatras.gr/en/content/courses/en/chemical-eng-processes-laboratory-ii			
Last Amendment	December 2016			

Unit Operations II

Module code	**CHM_855**			
Module title	***Unit Operations II***			
Status	Live	**Type**	Compulsory	
Category A	Core Chemical Engineering		**%**	70%
Category B	Chemical Engineering Practice		**%**	30%
Year of study	4	**Semester**	Fall	
ECTS credits	6	**Teaching Units**	4.	
Name of lecturer	Christakis Paraskeva			
Learning outcomes	**CAT**	**Description**		
	A	Students are trained in basic Unit Operations (Network of tubes, pumps, heat exchangers)		

Module code	CHM_855				
	B	Students learn to work with computing methodology and a commercial software to design unit operation processes s learn design unit operation processes			
	E	Students learn to design heat exchangers and calculate friction losses in network of tubes			
	I	Students learn to work and co-operate in multidisciplinary teams to present their results in original reports			
Competences Prerequisites	To attend the module the student is encouraged to refresh basic Fluid Mecanics and Heat Transfer conecpts.				
Module content	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.				
Recommended literature	1. Unit Operations of Chemical Engineering (7th edition). W. L. McCabe, J. C. Smith, P. Harriott. McGraw-Hill ISBN 007-124710-6				
	2. McCABE WARREN, SMITH JULIAN C., HARRIOTT PETER "ΒΑΣΙΚΕΣ ΔΙΕΡΓΑΣΙΕΣ ΧΗΜΙΚΗΣ ΜΗΧΑΝΙΚΗΣ, ΕΚΔΟΣΕΙΣ Α.ΤΖΙΟΛΑ & ΥΙΟΙ Ο.Ε., ΘΕΣ/ΝΙΚΗ, 2002				
	3. Σημειώσεις Φυσικών Διεργασιών ΙΙ, Α.Χ. Παγιατάκης, Εκδόσεις Πανεπιστημίου Πατρών				
Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**	
	2 h/w	2 h/w	2 h/w	2/semester	
Assessment type	Combined				
Assessment and grading methods	(Final exam) x 0.7 + 0.1 x Project + (laboratory grade) x 0.2 = Final Grade				
Instruction Language	Greek				
Erasmus availability	YES				
Module URL	http://www.chemeng.upatras.gr/en/content/courses/en/unit-operations-ii				
Last Amendment	December 2016				

Industrial Chemical Technologies

Module code	**CHM_835**			
Module title	***Industrial Chemical Technologies***			
Status	Live	**Type**	Compulsory	
Category A	Core Chemical Engineering		**%**	70%
Category B	Chemical Engineering Practice		**%**	30%
Year of study	4	**Semester**	Spring	
ECTS credits	5	**Teaching Units**	4	

<table>
<tr><td>Module code</td><td colspan="4">CHM_835</td></tr>
<tr><td>Name of lecturer(s)</td><td colspan="4">Dimitris Vayenas - Dimitrios Spartinos</td></tr>
<tr><td rowspan="5">Learning outcomes</td><td>CAT</td><td colspan="3">Description</td></tr>
<tr><td>A</td><td colspan="3">The understanding of Inorganic and Organic Chemical Technologies.</td></tr>
<tr><td>D</td><td colspan="3">Study of flow sheets.</td></tr>
<tr><td>F</td><td colspan="3">The combination of theoretical knowledge with practice.</td></tr>
<tr><td>K</td><td colspan="3">The students realize projects on Chemical Technologies after visiting Chemical Industries.</td></tr>
<tr><td>Competences Prerequisites</td><td colspan="4">There are no formal prerequisite modules. Basic knowledge by the following modules is necessary: Mass and Energy Balances, Unit Operations, Chemical Reaction Engineering.</td></tr>
<tr><td>Module content</td><td colspan="4">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_2SO4
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</td></tr>
<tr><td rowspan="3">Recommended literature</td><td colspan="4">1. Α. Θ. Σδούκου, Φ.Ι. Πομώνη, Ανόργανη Χημική Τεχνολογία, Εκδ. Τζιόλα (2010).</td></tr>
<tr><td colspan="4">2. Ν. Κλούρα, Βασική Ανόργανη Χημεία, Εκδ. Τραυλός (2002).</td></tr>
<tr><td colspan="4">3. Δ. Σπαρτινού, Οργανική Χημική Τεχνολογία, Εκδ. Πανεπιστημίου Πατρών (2012).</td></tr>
<tr><td rowspan="2">Teaching and learning methods</td><td>LECTURES</td><td>RECITATION</td><td>LAB/PRACTICE</td><td>PROJECT / HOMEWORK</td></tr>
<tr><td>2 h/w</td><td>2 h/w</td><td>4 h/w</td><td>1 team project/semester</td></tr>
</table>

Module code	**CHM_835**
Assessment type	Combined
Assessment and grading methods	1. Written examination (50%). 2. Team projects about industries, following visits by groups of students to chemical industries (50%). a) Written report (30%). b) Oral presentation (20%). Audience including industry specialists.
Instruction Language	Greek
Erasmus availability	YES
Module URL	http://eclass.upatras.gr/courses/CMNG2109
Last Amendment	December 2016

Process Health and Safety

Module code	**CHM_884**			
Module title	***Process Health and Safety***			
Status	Live	**Type**	Compulsory or Elective	
Category A	Core Chemical Engineering		**%**	70%
Category B	Chemical Engineering Practice		**%**	30%
Year of study	4	**Semester**	Spring	
ECTS credits	3	**Teaching Units**	3	
Name of lecturer	Dimitris Vayenas			
Learning outcomes	**CAT[5]**	**Description**		
	A	Ability to use basic knowledge to avoid risk		
	B	Ability to apply experimental and computing methodology, data analysis and interpretation to predict risk and avoid leakages, explosions etc.		
	D	Knowledge of chemical engineering principles and their technological applications		
	E	Ability to design and assess safe chemical processes including the use of process simulation software		
	G	Ability to function professionally and behave ethically, taking into account social, environmental and health and safety issues		
	I	Ability to cooperate with multidisciplinary teams		
	K	Ability to prepare and present projects		
Competences Prerequisites				
Module content	Meaning of risk- hazardousness Risk identification methods Frequency of potential risks occurrence Human factor Pressurized gas leakage Liquid leakage Two-phase vapor-liquid mist Fires Explosions gas cloud Bleve Explosions Toxic cloud dispersion Causes of equipment destruction Ignition			

Module code	**CHM_884**			
Recommended literature	1. Μ.Ι. Ασσαέλ, Κ.Ε. Κακοσίμος, Ανάλυση Επικινδυνότητας, Εκδ. Τζιόλα, 2008. ISBN: 976-960-418-148-3			
	2. R.E. Sanders, Chemical process safety, Elsevier, eBook ISBN: 075067749X			
Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	3 h/w	0 h/w	0 h/w	1/semester
Assessment type	Combined			
Assessment and grading methods	Written examination counts for 60% while the project counts for 40% of the final grade			
Instruction Language	Greek			
Erasmus availability	YES			
Module URL	https://eclass.upatras.gr/courses/CMNG2202/			
Last Amendment	January 2017			

Management Information Systems

Module code	**CHM_881**			
Module title	***Management Information Systems***			
Status	Live	**Type**	Elective	
Category A	Management & Economics		**%**	100%
Year of study	4	**Semester**	Spring	
ECTS credits	3	**Teaching Units**	3	
Name of lecturer(s)	Department of Mechanical Engineering & Aeronautics			

Operations Strategy I

Module code	**CHM_882**			
Module title	***Operations Strategy***			
Status	Live	**Type**	Elective	
Category A	Management & Economics		**%**	100%
Year of study	4	**Semester**	Spring	
ECTS credits	3	**Teaching Units**	3	
Name of lecturer(s)	Department of Mechanical Engineering & Aeronautics			

Technology – Innovation -Entrepreneurship

Module code	**CHM_883**			
Module title	***Technology – Innovation -Entrepreneurship***			
Status	Live	**Type**	Elective	
Category A	Management & Economics		**%**	100%
Year of study	4	**Semester**	Spring	
ECTS credits	3	**Teaching Units**	3	
Name of lecturer(s)	Department of Mechanical Engineering & Aeronautics			

Operations Research I

Module code	**CHM_885**			
Module title	***Operations Research I***			
Status	Live	**Type**	Elective	
Category A	Management & Economics		**%**	100%
Year of study	4	**Semester**	Spring	
ECTS credits	3	**Teaching Units**	3	
Name of lecturer(s)	Department of Mechanical Engineering & Aeronautics			

Technical Project Management

Module code	**CHM_797**			
Module title	***Technical Project Management***			
Status	Live	**Type**	Elective	
Category A	Management & Economics		**%**	100%
Year of study	1	**Semester**	Spring	
ECTS credits	3	**Teaching Units**	3	
Name of lecturer(s)	Department of Mechanical Engineering & Aeronautics			

Organisms, Populations & Environment

Module code	**CHM_886**			
Module title	***Organisms, Populations & Environment***			
Status	Live	**Type**	Elective	
Category A	Underpinning Mathematics, Science and Associated engineering		**%**	100%
Year of study	4	**Semester**	Spring	
ECTS credits	3	**Teaching Units**	3	
Name of lecturer(s)	Department of Biology			

Practical Training in Industry & Enterprises (Job Internship)

Module code	**CHM_898**			
Module title	***Practical Training in Industry & Enterprises***			
Status	Live	**Type**	Elective	
Category A	Chemical Engineering Practice		**%**	100%
Category B	Choose Module Category B		**%**	%
Year of study	4	**Semester**	Spring	
ECTS credits	3	**Teaching Units**	3	
Name of lecturer	George Angelopoulos			
Learning outcomes	**CAT**	**Description**		
	A	Gain work experience and develop skills		
	G	Experience a prospective career path		

Module code	**CHM_898**	
	B	Gain practical experience, by applying methods and theories learned in classes
	K	Network with professionals of the field, for references and future job opportunities
Competences Prerequisites	Prior Knowledge/Skills required NONE pre-requisites normally required (desired) NONE	
Module content	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. 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	

Recommended[8] literature	1. NONE			
	2. NONE			
	3. NONE			
Teaching and learning methods	**LECTURES**	**SEMINARS**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	Not applicable	Not applicable	Not applicable	Not applicable
Assessment type[9]	Combined			
Assessment and grading methods	Oral presentation of the work performed. Gained experience and main results. Evaluation of the submitted work report. Consideration of the employer's evaluation report			
Instruction Language	Greek			
Erasmus availability	NO			
Course URL	https://eclass.upatras.gr/courses/CMNG2152/			
Last Amendment	February 2017			

3.10 5th Year – 9th Semester

Wastewater Engineering

Module code	**CHM_E_A1**			
Module title	***Wastewater Engineering***			
Status	Live	**Type**	Elective	
Category A	Adv. Chem. Engineering (Depth)		**%**	50%
Category B	Adv. Chem. Engineering (Breadth)		**%**	50%
Year of study	5	**Semester**	Fall	
ECTS credits	4	**Teaching Units**	3	
Name of lecturers	Michael Kornaros - Dionissios Mantzavinos			
Learning outcomes	**CAT**	**Description**		
	A	Ability to apply biochemical engineering principles to wastewater treatment processes		
	C	Ability to formulate mathematical models able to describe physicochemical and/or biological processes pertaining to either municipal or industrial wastewater treatment		
	D	Knowledge of physicochemical (conventional/advanced oxidation) and biological processes and their application in wastewater treatment plants		
	E	Ability to design and assess both chemical (including advanced oxidation) as well as biological processes for municipal and industrial wastewater treatment systems		
Competences Prerequisites	There are no prerequisites for this module. However, students should have basic knowledge of mass and energy balances, unit operations and biochemical processes.			
Module content	Wastewater flowrates. 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. Disinfection. Sludge (biosolids) management. Sources and characteristics of industrial effluents. Methods of evaluation of the polluting loading. Physical and chemical treatment technologies: • Coagulation - flocculation • 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			
Recommended literature	1. "Μηχανική Υγρών Αποβλήτων. Επεξεργασία και Επαναχρησιμοποίηση - Τόμος Α" 4η Έκδοση, Metcalf & Eddy, Εκδ. Τζιόλα, 2006, Θεσ/νίκη. ISBN: 960-148-109-2			
	2. "Διαχείριση Υγρών Αποβλήτων", Γ. Λυμπεράτος και Δ. Βαγενάς, Εκδ. Τζιόλα, 2011, Θεσ/νίκη. ISBN: 978-960-418-346-3			

Module code	**CHM_E_A1**			
	3. Advanced Oxidation Processes for Water & Wastewater Treatment, Ed. S.A. Parsons, IWA Publishing, 2004			
Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	3 h/w	0 h/w	0 h/w	1/semester
Assessment type	Combined			
Assessment and grading methods	The assessment of each student's performance is as follows: 50% written examination 50% project			
Instruction Language	Greek			
Erasmus availability	YES			
Module URL	https://eclass.upatras.gr/courses/CMNG2143/			
Last Amendment	December 2016			

Process Optimization and Control

Module code	**CHM_E_A2**			
Module title	***Process Optimization and Control***			
Status	Live	**Type**	Elective	
Category A	Adv. Chem. Engineering (Depth)		**%**	100%
Category B	Choose Module Category B		**%**	%
Year of study	5	**Semester**	Fall	
ECTS credits	4	**Teaching Units**	3	
Name of lecturer	Ioannis Kookos			
Learning outcomes	**CAT**	**Description**		
	B	Ability to develop mathematical programming formulations for classical engineering design problems,		
	A	Ability to use computer software (MATLAB, GAMS) to solve process optimization problems		
	D	Ability to evaluate critically the solutions obtained using numerical software		
Competences Prerequisites	None			
Module content	Basic principles and definitions. Necessary conditions for optimality. General structure of optimization algorithms. Optimization without constraints. Linear and non-linear programming. Integer programming. Applications to the design of chemical/biochemical plants. Tuning of classical, fixed structure controllers, using classical optimization methodologies. Optimal Control problems and their numerical solution.			
Recommended literature	1. I. Kookos & A. Koutinas, Process and Systems Optimization, Tziola Publishing, 2014, in Greek			
	2. H. Taha, Operational Research, Tziola Publishing, 2007, translation in Greek			
Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	3h/w	0 h/w	0 h/w	1/semester

Module code	**CHM_E_A2**
Assessment type	Combined
Assessment and grading methods	Final exam, weekly projects.
Instruction Language	Greek
Erasmus availability	NO
Module URL	https://eclass.upatras.gr/courses/CMNG2188/
Last Amendment	December 2016

Bioreactor Analysis and Design

Module code	**CHM_E_A3**			
Module title	***Bioreactor Analysis and Design***			
Status[3]	Live	**Type**	Elective	
Category A	Adv. Chem. Engineering (Depth)		**%**	100%
Category B	Choose Module Category B		**%**	%
Year of study	5	**Semester**	Fall	
ECTS credits	4	**Teaching Units**	3	
Name of lecturer	Stavros Pavlou			
Learning outcomes	**CAT**	**Description**		
	A	Application of knowledge of basic biology, reaction engineering and biokinetics in designing and analyzing systems of bioreactors.		
	B	Application of mathematical and computational methods of analyzing and solving systems of differential equations representing mathematical models of bioreactors.		
	C	Constuction and computational analysis of mathematical models of systems of bioreactors.		
Competences Prerequisites	Knowledge of basic biology, principles of bioengineering, reaction engineering, mathematical and computational methods of analyzing and solving systems of differential equations.			
Module content	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.			
Recommended literature	1. Σ. Παύλου, Μαθηματικά μοντέλα μικροβιακής ανάπτυξης σε βιοαντιδραστήρες, Εκδόσεις Πανεπιστημίου Πατρών			
Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	3 h/w	0 h/w	0 h/w	10/semester

Module code	**CHM_E_A3**
Assessment type	Combined
Assessment and grading methods	Homework sets 20% Final exam 80%
Instruction Language	Greek
Erasmus availability	NO
Module URL	https://eclass.upatras.gr/courses/CMNG2192/
Last Amendment	January 2017

Heterogeneous Catalysis

Module code	**CHM_E_B1**			
Module title	***Heterogeneous Catalysis***			
Status	Live	**Type**	Elective	
Category A	Adv. Chem. Engineering (Depth)		**%**	100%
Category B	Choose Module Category B		**%**	%
Year of study	5	**Semester**	Fall	
ECTS credits	4	**Teaching Units**	3	
Name of lecturer	Symeon Bebelis			
Learning outcomes	**CAT**	**Description**		
	A	Knowledge of the fundamentals of thermodynamics and kinetics of the heterogeneous catalytic reactions.		
	A	Knowledge of the basic types of solid catalysts and of the most common methods used for their synthesis, characterization and assessment of performance.		
	A	Knowledge at the microscopic level of the general mechanism and of the basic aspects of chemisorption and catalytic action, for different types of solid catalysts.		
	A	Knowledge of the key features of the heterogeneous catalytic actions in selected processes of industrial and environmental significance		
	B	Ability to analyze experimental data of physisorption and chemisorption on solid catalyst surfaces and to identify the basic features of the mechanism of a heterogeneous catalytic reaction, on the basis of kinetic measurements and data resulting from the application of techniques of characterization of solid catalysts.		
	F	Ability to select the most suitable type of heterogeneous catalyst for a particular reaction and become involved in development of new or optimized catalysts.		
	K	Ability to clearly present in written as well as discuss solutions to homework exercises and problems related to heterogeneous catalysis.		
Competences Prerequisites	There are no prerequisite modules. The students should have a basic knowledge of General and Inorganic Chemistry, Organic Chemistry, Physical Chemistry and Chemical Thermodynamics and Kinetics.			
Module content	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			

Module code	CHM_E_B1
	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
Recommended literature	1. Lecture notes (Σ. Μπεμπέλης, Σ. Λαδάς, «Ετερογενής Κατάλυση», Πανεπιστήμιο Πατρών 2006)
Teaching and learning methods	**LECTURES**: 3 h/w; **RECITATION**: 0 h/w; **LAB/PRACTICE**: 0 h/w; **PROJECT / HOMEWORK**: 2/semester
Assessment type	Combined
Assessment and grading methods	1. *Final written exam* The written exams comprise mainly theoretical questions (part of them in the form of multiple-choice questions) but also solving of simple exercises. 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 assignments* (two homework sets), on volunteer basis.
Instruction Language	Greek
Erasmus availability	NO
Module URL	https://eclass.upatras.gr/courses/CMNG2147/
Last Amendment	January 2017

Molecular Spectroscopy

Module code	CHM_E_B2		
Module title	***Molecular Spectroscopy***		
Status	Live	**Type**	Elective
Category A	Adv. Chem. Engineering (Breadth)	**%**	100%
Category B	Choose Module Category B	**%**	%
Year of study	5	**Semester**	Fall
ECTS credits	4	**Teaching Units**	3
Name of lecturer	Soghomon Boghosian		
Learning outcomes	**CAT**	**Description**	
	A	At the end of this module, students should be able to: understand the concepts of absorption, stimulated and spontaneous emission of radiation	
	A	Explain the general principles and describe the instrumentation of rotational and vibrational spectroscopies	

Module code	CHM_E_B2				
	A	Apply basic concepts to predict the appearance of microwave, IR and UV-vis spectra of organic and inorganic molecules			
	A	Show familiarity with character tables and symmetry group operations, and distinguish between infrared and Raman active vibrations			
	A	Apply molecular spectroscopy in research experiments to determine appropriate experimental methods that are most relevant to a specific problem			
Competences Prerequisites	The students should have completed successfully the module CHM_421 (Physical Chemistry).				
Module content	- 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.				
Recommended literature	1. P.W. Atkins and J. de Paula, "Physical Chemistry", 9th Edition, Oxford University Press, 2010 (Greek translation, 2014).				
	2. Στέφανος Τραχανάς, "Στοιχειώδης Κβαντική Φυσική", Πανεπιστημιακές Εκδόσεις Κρήτης, 2012.				
	3. Ν.Α. Κατσάνος, "Φυσικοχημεία, Βασική θεώρηση", Εκδόσεις Παπαζήση.				
Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**	
	3 h/w	0 h/w	0 h/w	5/semester	
Assessment type	Written Examination				
Assessment and grading methods					
Instruction Language	Greek				
Erasmus availability	NO				
Module URL	https://eclass.upatras.gr/courses/CMNG2173/				
Last Amendment	December 2016				

Surface Science

Module code	**CHM_E_B3**			
Module title	***Surface Science***			
Status	Live	**Type**	Elective	
Category A	Adv. Chem. Engineering (Breadth)		**%**	100%
Category B	Choose Module Category B		**%**	%

Module code	**CHM_E_B3**			
Year of study	5		**Semester**	Fall
ECTS credits	4		**Teaching Units**	3
Name of lecturer	Georgios Kyriakou			
Learning outcomes	**CAT**	**Description**		
	A	Apply concepts and methods of Physics and Chemistry of Solids in understanding the behavior of surfaces and interfaces in Materials Engineering processes.		
	B	Ability to handle and interpret experimental data from various surface analysis and characterization techniques.		
	F	Ability to extend chemical and bulk materials engineering concepts, in diverse new technological areas pertaining to surface/interface treatment and properties.		
Competences Prerequisites	Students are expected to have basic knowledge from Physical Chemistry, Materials Science, Instrumental Chemical Analysis			
Module content	- Introduction to Solid Surfaces and Interfaces. The necessity of Ultra-high-vacuum in studying atomically clean surfaces. An Introduction to Vacuum Science and Technology. - Surface chemical analysis. Introduction to the main spectroscopic techniques for solid surface chemical characterization. - Atomic structure of solid surfaces. Elements of crystallography in two dimensions. Crystal structure determination using Electron Diffraction and Scanning Probe Microscopy techniques. - Electronic properties of solid surfaces. Work Function - Concepts and measurement techniques. Contact potential. Metal - semiconductor interfaces. - Surface atomic motion. Diffusion. Surface melting. - Adsorption processes on solid surfaces. Physisorption and chemisorption. Characterization of adsorbed layers. Growth and characterization of thin films. Epitaxy. Applications in the area of microelectronics.			
Recommended literature	1. Instructors notes are distributed. Internet sources are suggested.			
Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	3 h/w	0 h/w	0 h/w	0/semester
Assessment type	Written Examination			
Assessment and grading methods				
Instruction Language	Greek			
Erasmus availability	NO			
Module URL	https://eclass.upatras.gr/courses/CMNG2135/			
Last Amendment	December 2016			

Production & Shaping of Industrial Materials

Module code	**CHM_E_Γ1**			
Module title	***Production & Shaping of Industrial Materials***			
Status	Live	**Type**	Elective	
Category A	Adv. Chem. Engineering (Depth)		**%**	50%
Category B	Adv. Chem. Engineering (Breadth)		**%**	50%
Year of study	5	**Semester**	Fall	
ECTS credits	4	**Teaching Units**	3	

<table>
<tr><td>Module code</td><td colspan="4">CHM_E_Γ1</td></tr>
<tr><td>Name of lecturers</td><td colspan="4">George Angelopoulos, Yannis Dimakopoulos, Panagiotis Nikolopoulos</td></tr>
<tr><td rowspan="5">Learning outcomes</td><td>CAT</td><td colspan="3">Description</td></tr>
<tr><td>D</td><td colspan="3">To use chemical and physical methods for producing metals</td></tr>
<tr><td>D</td><td colspan="3">To be able to control the processing variables for the melts of industrial materials</td></tr>
<tr><td>D</td><td colspan="3">To be able to take samples from the process and make test and analysis</td></tr>
<tr><td>G</td><td colspan="3">To be able to investigate if the methods are economical,efficient and environmentally acceptable</td></tr>
<tr><td>Competences Prerequisites</td><td colspan="4">-</td></tr>
<tr><td>Module content</td><td colspan="4">1) Production of Iron and Steel (3-4 lectues):
Iron and steel production. Iron ore. From iron ore to steel. Reduction of minerals,coke, blast furnace. Reduction reactions. Ellingham diagrams. Boudouard equilibrium and Chaudron curves. Mass balance in the blast furnace. Cast iron and categories. Pretreatment of iron. The making of steel. Refining processes. Reactions refining. Processes of oxygen. Electric arc furnace. Categories and classification steels.
2) Production /Formatting Polymeric Materials (3-4 lectures):
Part 1: Basic Principles of Polymer Processing (1-2 weeks)
Historical Background: • From Natural to Synthetic Rubber • Cellulose and the $10,000 Idea•Galalith - The Milk Stone•Leo Baekeland and the Plastics Industry•Herman Mark and the American Polymer Education•Wallace Hume Carothers and Synthetic Polymers•Polyethylene - A Product of Brain and Brawn•The Super Fiber and the Woman Who Invented it• One Last Word - Plastics
Structure of Polymers: • Structure of Polymers• Macromolecular• Conformation and Configuration of Polymer Molecules• Arrangement of Polymer Molecules• Copolymers and Polymer Blends• Polymer Additives
Thermal Properties of Polymers: • Material Properties • Measuring Thermal Data
Rheology of Polymer Melts: • Viscous Flow Models• Simplified Flow Models Common in Polymer Processing • Viscoelastic Flow Models • Rheometry• Surface Tension
Part 2: Influence of Processing on Properties: Introduction to Processing (3-4 weeks)
Historical Background:• Extrusion• Mixing Processes• Injection Molding• Special Injection Molding Processes• Secondary Shaping• Calendering• Coating• Compression Molding• Foaming• Rotational Molding
Anisotropy Development During Processing: •Orientation in the Final Part •Predicting Orientation in the Final Part • Fiber Damage
Solidification of Polymers: •Solidification of Thermoplastics• Solidification of Thermosets• Residual Stresses and Warpage of Polymeric Parts
3) Surface Treatments of Iron and Galvanisation(1 lecture):
Methods of galvanisation, Intermetallic phases Fe-Z
4) Inorganic binders Materials -Cements(2-3 lectures):
Technology cement manufacturing, Admixtures and cement, Technology to address environmental impacts, Environmental cement footprint
5) Ceramics(3-4 lectures):
Introduction to Ceramics, Production of ceramic powders, Formatting and aggregation (sintering) Ceramics, properties of Ceramics, Failure Analysis Ceramics, Applications Ceramics [Traditional, Technical and Advanced Ceramics (structural and functional)], Joining Materials (cermet)</td></tr>
<tr><td>Recommended literature</td><td colspan="4">1. Lorraine F. Francis, "Materials Processing:A Unified Aproach to Processinf of Metals, Ceramics, and Polymers",1st Edition,Academic Press, 2016</td></tr>
<tr><td rowspan="2">Teaching and learning methods</td><td>LECTURES</td><td>RECITATION</td><td>LAB/PRACTICE</td><td>PROJECT / HOMEWORK</td></tr>
<tr><td>3 h/w</td><td>0 h/w</td><td>0 h/w</td><td>2/semester</td></tr>
</table>

Module code	**CHM_E_Γ1**
Assessment type	During the semester
Assessment and grading methods	Describe assessment methods and module mark calculation
Instruction Language	Greek
Erasmus availability	NO
Module URL	Insert eclass address (mandatory for all modules)
Last Amendment	January 2017

Nanomaterials & Nanotechnology

Module code	**CHM_E_Γ2**			
Module title	***Nanomaterials & Nanotechnology***			
Status	Live	**Type**	Elective	
Category A	Adv. Chem. Engineering (Depth)		**%**	50%
Category B	Adv. Chem. Engineering (Practice)		**%**	50%
Year of study	5	**Semester**	Fall	
ECTS credits	4	**Teaching Units**	3	
Name of lecturers	Costas Galiotis - Stella Kennou			
Learning outcomes	**CAT**	**Description**		
	A	Nanomaterials and nanotechnology for engineering applications.		
	D	Production and properties of a whole range of nanomaterials inclusive of nanostructured polymers and nanocomposites materials.		
Competences Prerequisites	There are no prerequisite modules. It is however, recommended that students should have knowledge of the basic principles of Materials Science.			
Module content	A. Introduction. Historical perspective. Advantages and applications of nanotechnology. Future perspectives. B. Brief description of electronic, mechanical, electrical, magnetic and optical properties of materials. Influence of the nanoscale on these properties. C. Classification of the nanomaterials as zero-, one- and two- dimensional Nanostructures (nano particles, nano wires/ nanotubes /nano rods, graphene and other 2D materials. Properties and applications. D. Overview of Nano Fabrication Methods: Top-down and bottom-up approaches, lithography, deposition, CVD, PVD, wet etching, dry etching and material modification methods, pattern transfer methods processes and equipment. E. Nanostructured polymers- 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. Exploitation of the micro-phase separation of the block copolymers for the creation of useful nanostructures. F. Nanocomposite materials - types of inclusions, type of matrices, dispersion of inclusions, modification of matrix at nanoscale, production methods (shear mixing, centrifugal mixer, extrusion etc). Properties (electrical, mechanical, etc.) and applications. G. Characterization Methods and Tools - Optical microscopy, Profilometry, Ellipsometry, IR and Raman spectroscopies, Scanning Electron, Microscope, AFM etc.. H. Application of nano materials, Carbon Nano Tubes, Quantum dots, Graphene, Organic compounds etc			
Recommended literature	1. Lecture notes			

Module code	**CHM_E_Γ2**			
Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	3 h/w	0 h/w	0 h/w	1/semester
Assessment type	Combined			
Assessment and grading methods	1. Written examination (50% of total mark) 2. Individual project per student on a specific nanotechnology topic (50% of total mark).			
Instruction Language	Greek			
Erasmus availability	YES			
Module URL	https://eclass.upatras.gr/courses/CMNG2200			
Last Amendment	January 2017			

Biomaterials

Module code	**CHM_E_Γ3**			
Module title	***Biomaterials***			
Status	Live	**Type**	Elective	
Category A	Adv. Chem. Engineering (Breadth)		**%**	50%
Category B	Adv. Chem. Engineering (Depth)		**%**	50%
Year of study	5	**Semester**	Fall	
ECTS credits	3	**Teaching Units**	3	
Name of lecturers	Eleftherios Amanatides - George Pasparakis			
Learning outcomes	**CAT**	**Description**		
	F	The meanings of biocompatibility and toxicity of biomaterials		
	F	The different types of biomaterials depending on the biomedical application and the most important mechanical, physicochemical and biological properties of these materials.		
	J	The most important mechanisms of cells response to wounds caused by biomaterials implantation		
	F	The most important in-vitro and in-vivo test of biomaterials for monitoring their biocompatibility and toxicity		
	J	The most important mechanisms of cells response to wounds caused by biomaterials implantation		
	F	The most important types of biomaterials infection and prevention methods		
	D	The main methods and techniques for drug delivery control and targeting		
Competences Prerequisites	There are no prerequisite modules. It is, however, recommended that students should have basic knowledge of Materials Science, Polymers Science and Biology			

Module code	**CHM_E_Γ3**
Module content[7]	A. Introduction to biomaterials and biocompatibility / toxicity. 1st, 2nd and 3d generation biomaterials. Replacement, Reconstruction and regeneration of basic organs B. Types of biomaterials: Synthesis and properties of metallic, ceramic and polymeric biomaterials Mechanical and physicochemical properties . Hydrogels, Natural Biomaterials, medical fibers and textiles. C. Methods for surface modification of biomaterials. D. Proteins – Cells – Tissues: Mechanisms of interactions with biomaterial surfaces. Cells and tissue responses to implantation wounds E. Biomaterials Infection. Main types and prevention methods F. Biomaterials for drug delivery applications G. FDA approvals and CE marking rules and classifications of biomaterials
Recommended literature	1. Biomaterials Science: An Introduction to Materials in Medicine, Second Edition [electronic resource] - 2nd edition/2004 - Author: 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
	3. Biomaterials The Intersection of Biology and Materials Science, J. S. Temenoff, A. G. Mikos ISBN 978-0-13-009710-1
Teaching and learning methods	see below
Assessment type	Combined
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)
Instruction Language	Greek
Erasmus availability	YES
Module URL	https://eclass.upatras.gr/courses/CMNG2117/
Last Amendment	December 2016

Teaching and learning methods:

LECTURES	RECITATION	LAB/PRACTICE	PROJECT / HOMEWORK
3 h/w	0 h/w	N0 h/w	1/semester

3.11 5th Year – 10th Semester

Applications & Simulation of Transport Phenomena

Module code	**CHM_E69**			
Module title	***Applications & Simulation of Transport Phenomena***			
Status	Live	**Type**	Elective	
Category A	Adv. Chem. Engineering (Depth)		**%**	100%
Category B	Choose Module Category B		**%**	%
Year of study	5	**Semester**	Spring	
ECTS credits	4	**Teaching Units**	3	
Name of lecturer	Yannis Dimakopoulos			
Learning outcomes	**CAT**	**Description**		
	A	The basics of computational transport phenomena		
	B	How to discretize 3d spaces and construct high quality meshes		
	B	How to solve realistic problems		
	C	Develop a student's ability for result presentations and data visualization of engineering problems.		
Competences Prerequisites	Prerequisite modules have not been set. The students however, must have good knowledge of Fluid Mechanics, Heat & Mass Transfer, Numerical Methods			
Module content[7]	1) Introduction to Finte Volume, Finite Element, and Finite Difference Methods 2) 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. 3) 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. 4) 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. 4) 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 5) 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 6) 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 7) Introduction to OpenFoam 8) Applications with OpenFoam			

Module code	**CHM_E69**			
Recommended literature	1. H. K. Versteeg and W. Malalasekera, 'An Introduction to Computational Fluid Dynamics: the Finite Volume Method', Longman Scientific & Technical, 2007 (Translation in Greek, 2015).			
	2. J. H. Ferziger and M. Peric, 'Computational Methods for Fluid Dynamics', Springer, 2004.			
	3. C. Hirsch, 'Numerical Computation of Internal and External Flows: Volume 1, Fundamentals of Numerical Discretization', 2nd Edition, John Wiley & Sons, 2001.			
Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	3 h/w	0 h/w	0 h/w	6/semester
Assessment type	During the semester			
Assessment and grading methods	1. Exercises (45% of the final grade). 2. Research Project based on the recent scientific literature (55%)			
Instruction Language	Greek			
Erasmus availability	YES			
Module URL	https://eclass.upatras.gr/modules/auth/opencourses.php?fc=59			
Last Amendment	January 2017			

Solid Wastes Management

Module code	**CHM_E_A5**			
Module title	***Solid Wastes Management***			
Status	Live	**Type**	Elective	
Category A	Adv. Chem. Engineering (Breadth)		**%**	100%
Category B	Choose Module Category B		**%**	%
Year of study	5	**Semester**	Spring	
ECTS credits	4	**Teaching Units**	3	
Name of lecturer	Michael Kornaros			
Learning outcomes	**CAT**	**Description**		
	A	Ability to apply mass and energy balances to solid waste management processes		
	D	Knowledge of mass and energy balances and unit operations as they apply in thermal and biological processes of solid waste managament		
	E	Ability to design and assess mechanical, chemical and biological processes for integrated solid waste management		
	F	Abiity to develop and implement new technologies and methods pertaining in solid waste management		
Competences Prerequisites	There are no prerequisites for this module. However, students should have basic knowledge of mass and energy balances and unit operations.			
Module content	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.			
Recommended literature	1. "Βιώσιμη Διαχείριση Αστικών Στερεών Αποβλήτων", Δ.Χ. Παναγιωτακόπουλος, Εκδ. Ζυγός, 2007, 2η Εκδοση, Θεσσαλονίκη, ISBN: 978-960-8065-31-4			

Module code	**CHM_E_A5**
	2. "Εγχειρίδιο Διαχείρισης Στερεών Αποβλήτων", G. Tchobanoglous, F. Kreith. Μετάφραση: Α. Κούγκολος, Α. Καραγιαννίδης, Π. Σαμαράς, Εκδ. Τζιόλα, 2010, 2η Εκδοση, Θεσ/νίκη. ISBN 978-960-418-247-3

Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	3 h/w	0 h/w	0 h/w	0/semester

Assessment type	Combined
Assessment and grading methods	The assessment of each student's performance is based on tests given to students each week (60% of total mark) and the final written examination (40% of total mark).
Instruction Language	Greek
Erasmus availability	YES
Module URL	https://eclass.upatras.gr/courses/CMNG2144/
Last Amendment	December 2016

Air Pollution Management

Module code	**CHM_E_A6**			
Module title	***Air Pollution Management***			
Status	Live	**Type**	Elective	
Category A	Adv. Chem. Engineering (Breadth)		**%**	100%
Category B	Choose Module Category B		**%**	%
Year of study	5	**Semester**	Spring	
ECTS credits	4	**Teaching Units**	3	
Name of lecturer	Spyros Pandis			

Learning outcomes	**CAT[5]**	**Description**
	A	Learning of how to apply the principles of chemical engineering (classical and chemical thermodynamics, chemical kinetics, fluid mechanics, mass and heat transfer) to improve air quality.
	J	Ability to recognize contemporary environmental issues related to air pollution and climate change.

Competences Prerequisites	Chemical Thermodynamics; Transport Phenomena; Reaction Engineering
Module content	The Atmosphere. History and development, atmospheric layers, pressure change with altitude, atmospheric composition, transport times in the atmosphere, major gas-phase pollutants, atmospheric particulate matter, toxics, standards and regulations. Tropospheric chemistry. Basic photochemical cycle of NO_2, NO and O_3, atmospheric chemistry of CO, formaldehyde chemistry, chemistry of the clean atmosphere, tropospheric ozone, the role of organic compounds and NO_x in ozone formation. Aqueous-phase chemistry. Water in the atmosphere, absorption of pollutants in clouds, sulfuric acid formation, nitric acid formation. Atmospheric particulate matter. Chemical composition and size distribution, thermodynamic principles, water and particulate matter, thermodynamics of atmospheric particles, organic components of aerosols, primary and secondary aerosols. Wet deposition and acid rain General principles, collection of gas-phase pollutants by rain, collection of particles by rain, acid deposition, synthesis of processes leading to acid deposition.

Module code	**CHM_E_A6**			
Recommended literature	1. Λαζαρίδης Μ., Ατμοσφαιρική Ρύπανση με Στοιχεία Μετεωρολογίας, 2η έκδοση, Εκδ. Τζιόλα, 2010.			
	2. Γεντεκάκης Ι., Ατμοσφαιρική Ρύπανση, Κλειδάριθμος, 2010.			
	3. Seinfeld J. H. and Pandis S. N., Atmospheric Chemistry: Air Pollution to Global Change, 2nd edition, John Wiley and Sons, New York, 2006.			
Teaching and learning methods	**LECTURES**	**SEMINARS**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	3 h/w	0 h/w	0 h/w	6/semester
Assessment type	Combined			
Assessment and grading methods	The final grade is 40% of the grade of homeworks and 60% of the grade of the final exam.			
Instruction Language	Greek and English			
Erasmus availability	YES			
Course URL	https://eclass.upatras.gr/courses/CMNG2119/			
Last Amendment	January 2017			

Reactor Analysis and Design

Module code	**CHM_E_B4**			
Module title	***Reactor Analysis and Design***			
Status	Live	**Type**	Elective	
Category A	Adv. Chem. Engineering (Depth)		**%**	100%
Category B	Choose Module Category B		**%**	%
Year of study	5	**Semester**	Spring	
ECTS credits	4	**Teaching Units**	3	
Name of lecturer	Symeon Bebelis - Dimitrios Spartinos			
Learning outcomes	**CAT**[5]	**Description**		
	D	A good understanding of the operation of basic heterogeneous chemical reactors.		
	D	Familiarization with the models which have been proposed for the simulation of catalytic reactors and their basic principles.		
	D	Knowledge in depth of the basic pseudo-homogeneous model for fixed bed reactors		
	D	Ability to understand basic principles of analysis and design of fluidized-bed and three-phase catalytic reactors.		
	C	Ability to design fixed bed reactors with simple pseudo-homogeneous models.		
Competences Prerequisites	Chemical Reaction Engineering I and II			
Module content[7]	Introduction to the design of catalytic reactors Fixed bed reactors: a) Pseudo-homogeneous models, b)Heterogeneous models Two examples of simulation of fixed bed reactors Fluidized-bed reactors Three-phase reactors			
Recommended literature	1. X. E. Verykios "Heterogeneous Catalytic Reactions and Reactors", Costarakis Press, Athens, in Greek			
	2. S. Fogler, " Elements of Chemical Reaction Engineering", 4^{th} ed., Pearson Education, 2006			

Module code	**CHM_E_B4**			
	3. J. M. Smith, "Chemical Engineering Kinetics", 3rd ed., McGraw-Hill, 1981			
	4. O. Levenspiel, "Chemical Reaction Engineering", 3rd ed., John Wiley & Sons, 1999			
Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	3 h/w	0 h/w	0 h/w	0/semester
Assessment type	Written Examination			
Assessment and grading methods	a) Written homeworks b) Presentation in the classroom and discussion of the solutions of the homeworks c) Written examination at the end of the semenster, consisting of theoretical questions and exercises			
Instruction Language	Greek			
Erasmus availability	NO			
Module URL				
Last Amendment	January 2017			

Electrochemical Processes

Module code	**CHM_E_B5**			
Module title	***Electrochemical Processes***			
Status	Live	**Type**	Elective	
Category A	Adv. Chem. Engineering (Depth)		**%**	100%
Category B	Choose Module Category B		**%**	%
Year of study	5	**Semester**	Spring	
ECTS credits	4	**Teaching Units**	3	
Name of lecturer	Symeon Bebelis			
Learning outcomes	**CAT**	**Description**		
	A	Ability to describe the modes of operation of electrochemical systems, the different types of ionic conductors, the interactions between ions in electrolytic solutions and the fundamental parameters and laws which concern ion transfer and electrical conduction in a homogeneous electrolyte phase.		
	A	Ability to describe the structure of an electrode/electrolyte interphase and explain the appearance of potential difference across it, as well as to formulate the condition of thermodynamic equilibrium for an electrode/electrolyte interphase or an electrochemical reaction.		
	A	Ability to describe the factors and mechanisms which determine the rate of an electrochemical reaction and control the operation of electrochemical systems under non-equilibrium conditions, as well as to express the rate of a multistep electrochemical reaction as a function of measurable parameters.		
	B	Ability to explain and implement equations for calculation of the ionic strength, activity coefficients, conductivity and related parameters in electrolyte solutions, as well as of the conductivity temperature dependence in electrolyte melts and solid electrolytes.		
	B	Ability to explain and implement equations for calculation of the standard emf of an electrochemical cell using standard electrode potentials data or thermodynamic data, for correlation of the equilibrium electrode potential or the emf with the activities of the electroactive species, and for prediction of the spontaneous direction of a redox reaction using electrochemical data.		

Module code	**CHM_E_B5**	
	B	Ability to explain and implement equations for calculation of the overpotentials developing during operation of an electrochemical cell as well of the operating potential of the cell, for a given current density.
	K	Ability to clearly present in written as well as discuss solutions to homework exercises and problems related to electrochemical processes.
Competences Prerequisites	The students should have basic knowledge of Physical Chemistry, with focus on Chemical Thermodynamics and Chemical Kinetics.	
Module content	*Introduction to electrochemistry:* Electrochemical vs. purely chemical reactions. Electrolytic and galvanic cells. *Ions and electrolytes*: Activities of ions in electrolyte solutions - Activity coefficients - Debye-Hückel theory. Mechanisms of ion transfer and electrical conduction in electrolyte solutions. Electrolyte melts. Solid electrolytes. *Electrode/electrolyte interphases and electrochemical cells:* The structure of the electrode/electrolyte interphase and the potential difference across it. Polarizable and non-polarizable interphases. Reference electrodes. The electrochemical series. The IUPAC conventions for electrochemical cells and for the sign of electromotive force. Prediction of the spontaneous direction of redox reactions using electrode potential data. *Thermodynamics of electrochemical reactions*: 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 the rate of an electrochemical reaction. Definition and measurement of electrode overpotential. Activation overpotential. The Butler-Volmer equation. The Tafel equation. Concentration overpotential and limiting current density. Ohmic overpotential. Operating potential of an electrochemical cell. Kinetic models for multistep electrochemical reactions. *Electrocatalysis and Electrochemical Promotion of Catalysis:* Basic concepts	

Recommended literature	
	1. Ν. Κουλουμπή, "Ηλεκτροχημεία", Εκδόσεις Συμεών, Αθήνα, 2005
	2. Ι. Α. Μουμτζής και Δ. Π. Σαζού, "Ηλεκτροχημεία", Εκδόσεις Ζήτη, Θεσσαλονίκη, 1997

Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	3 h/w	0 h/w	0 h/w	3-4 /semester

Assessment type	Combined
Assessment and grading methods	1. *Final written exam* The written exams comprise mainly theoretical questions (part of them in the form of multiple-choice questions) but also solving of simple exercises. 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 assignments* (3-4 homework sets), on volunteer basis.
Instruction Language	Greek
Erasmus availability	NO
Module URL	https://eclass.upatras.gr/courses/CMNG2149/
Last Amendment	January 2017

Suspensions and Emulsions

Module code	**CHM_E_B6**			
Module title	***Suspensions and Emulsions***			
Status	Live	**Type**	Elective	
Category A	Adv. Chem. Engineering (Breadth)		**%**	100%
Category B	Choose Module Category B		**%**	%
Year of study	5	**Semester**	Spring	
ECTS credits	4	**Teaching Units**	4	
Name of lecturer	Dimitra Kanellopoulou			

Learning outcomes	**CAT**	**Description**
	D	Acquaintance with dispersed systems (Definitions, preparation, characterization)
	A	Deviation of electrolyte solutions from ideal behaviour. Ion-ion interactions.
	A	Mechanism of development of surface charge on particles suspended in electrolyte solutions
	F	Methods and techniques of measurement of surface charge of colloids suspended in electrolyte solutions
	A	Films and Foams
	D	Stability of colloid suspensions and of foams. Theoretical and practical aspects
	A	Kinetics of destabilization of colloidal systems

Competences Prerequisites	Prerequisites desired: Knowledge of electrolyte solutions theory
Module content	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
Recommended literature	1. Κ. Παναγιώτου, Διεπιφανειακά Φαινόμενα & Κολλοειδή Συστήματα, Εκδ. Ζήτη, Θεσσαλονίκη, 1998
	2. Π.Κουτσούκος, Χημεία Κολλοειδών, Πανεπιστήμιο Πατρών 1996

Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	3 h/w	0 h/w	0 h/w	5/semester

Assessment type	Written Examination
Assessment and grading methods	Final mark based on the final written exam. Homework assignments are taken into consideration.
Instruction Language	Greek and English
Erasmus availability	YES
Module URL	https://eclass.upatras.gr/courses/CMNG2128/
Last Amendment	June 2016

Microelectronics Technology

Module code	**CHM_E_Γ4**				
Module title	***Microelectronics Technology***				
Status	Live	**Type**	Elective		
Category A	Adv. Chem. Engineering (Breadth)		**%**	70%	
Category B	Adv. Chem. Engineering (Depth)		**%**	30%	
Year of study	5	**Semester**	Spring		
ECTS credits	4	**Teaching Units**	4		
Name of lecturer	E. Farsari				
Learning outcomes	**CAT**	**Description**			
	A	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.			
	D	Application of reactor design and transport phenomena in the microscopic processing steps of IC fabrication.			
	D	Ability to apply Chemical Engineering Principles on a different scale in non-classical chemical engineering problems			
Competences Prerequisites	Prerequisites desired: Materials Science, Chemical Kinetics, Reactor Design and Transport Phenomena.				
Module content	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.				
Recommended literature	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				
Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**	
	3 h/w	0 h/w	0 h/w	2	
Assessment type	Combined				
Assessment and grading methods	Final mark based on the final written exam. 4 written tests and 2 homework assignments are taken into consideration.				
Instruction Language	Greek and English				
Erasmus availability	YES				

Module code	CHM_E_Γ4
Module URL	https://eclass.upatras.gr/courses/CMNG2103/
Last Amendment	June 2016

Corrosion and Materials Protection

Module code	CHM_E_Γ5			
Module title	*Corrosion and Materials Protection*			
Status	Live	Type	Elective	
Category A	Adv. Chem. Engineering (Depth)		%	50%
Category B	Adv. Chem. Engineering (Breadth)		%	50%
Year of study	5	Semester	Spring	
ECTS credits	4	Teaching Units	3	
Name of lecturers	Konstantinos Dassios			

Learning outcomes	CAT	Description
	A	Fundamental understanding of the principles of electrochemistry and materials science relevant to corrosion.
	A	Understanding of the causes and mechanism of the various forms of corrosion
	A	Knowledge of the effect of materials composition and microstructure on their behavior in corrosive environment, as well as of the effect of electrolyte composition on corrosion behavior of metals.
	B	Knowledge of methodologies for prediction, measurement and analysis of materials performance concerning corrosion.
	B	Ability to identify and select corrosion-resistant materials for use in corresponding corrosive environments.
	A	Knowledge of practices for the prevention and remediation of corrosion.
	F	Ability to propose economically viable solutions for solving or reducing corrosion problems at manageable levels.

Competences Prerequisites	Basic knowledge of Physical Chemistry (with focusing on basic knowledge of Electrochemistry) Thermodynamics, Kinetics and Materials Science.
Module content	*A. Introduction to corrosion - Fundamental aspects:* Definition, characteristics and importance of corrosion. The thermodynamic aspects of corrosion. The electrochemical theory of corrosion. Galvanic couples. Mixed potentials. Mechanism of oxidation of metals in aqueous solutions. Reduction reactions accompanying the corrosion of metals. Corrosion tendency of materials and factors affecting the corrosion rate. Measurement of corrosion and investigation of corrosion mechanism (parameters, methods). Construction and use of (thermodynamic) Pourbaix diagrams and (kinetic) Evans diagrams. Mechanism of iron corrosion. Solid products of corrosion Mechanism of corrosion of aluminum and various alloys. Passivation. The role of microstructure on corrosion. *B: Forms of corrosion and related factors* Uniform and localized corrosion. Galvanic corrosion. Pitting and crevice corrosion. Cavitation corrosion. Intergranular corrosion. Stress-corrosion cracking. Corrosion fatigue. Hydrogen embrittlement. Erosion corrosion. Atmospheric corrosion. Corrosion in concrete. Microbial corrosion. Corrosion of nanostructures. Corrosion in non-aqueous electrolytes. High-temperature corrosion. Γ. *Corrosion protection and prevention* Selection of materials resistant to corrosion. Active and passive corrosion protection methods. Cathodic and anodic protection, corrosion resistant coatings, corrosion inhibitors,

Module code	**CHM_E_Γ5**			
	passivators. Techno-economic criteria for selecting the most suitable method. Evaluation and performance monitoring of corrosion protection methods. Monitoring of corrosion in structures. Examples of corrosion failures.			
Recommended literature	1. "Διάβρωση και προστασία υλικών", Π. Βασιλείου, Θ. Σκουλικίδης, Εκδ. Συμεών (Ε. Καλαμαρά), Αθήνα (2007) ISBN 978-960-7888-85-3			
	2. "Principles of corrosion engineering and corrosion control, Zaki Ahmad, Elsevier Ltd, Oxford (2006), e-book, ISBN: 978-0-7506-5924-6			
	3. "Η διάβρωση και προστασία των μετάλλων με απλά λόγια" Α. Λεκάτου, Εκδ. Νημερτής (2013), ISBN 978-960-99591-2-4.			
Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	3 h/w	N h/w	0 h/w	0/semester
Assessment type	Combined			
Assessment and grading methods	-Final written exam -Homework assignments, on volunteer basis. -Laboratory projects (practice, reports) The final mark is mainly based on the final written exam. Homework assignments and laboratory projects are taken into consideration (homework bonus).			
Instruction Language	Greek			
Erasmus availability	NO			
Module URL	https://eclass.upatras.gr/courses/CMNG2204/			
Last Amendment	January 2017			

Materials for Energy Applications

Module code	**CHM_E_C6**			
Module title	***Materials for energy applications***			
Status	Live	**Type**	Elective	
Category A	Adv. Chem. Engineering (Breadth)		**%**	70%
Category B	Adv. Chem. Engineering (Depth)		**%**	30%
Year of study	5	**Semester**	Spring	
ECTS credits	3	**Teaching Units**	3.	
Name of lecturers	Konstantinos Dassios – Costas Galiotis			
Learning outcomes	**CAT**	**Description**		
	D	The basic types of renewable energy sources and the main technologies for their utilization		
	F	The fundamental properties and production methods for materials used in energy applications		
	F	The main types of composite and nanocomposite materials used in energy saving applications and their main methods of production and mechanical properties		
	D	The main photovoltaic technologies, the fundamental principles of solar modules operation and the design of photovoltaics plants		
	D	The basic optical and thermal properties of materials used in passive and active thermal solar systems		

Module code	**CHM_E_C6**	
	F	The main types of wind generators, the materials used for their construction and the energy production from wind plants
	D	The fundamental principles of steam engines, the materials used as engine components and their main properties and failure mechanisms.
Competences Prerequisites	There are no prerequisite modules. It is however, recommended that students should have knowledge of the basic principles of Materials Science and fundamendals of systems energy balance	
Module content[7]	A. Introduction to Renewable Energy Systems and utilization technologies. Current status in Greece, Europe and worldwide. B. Fundamental properties of materials used in energy production. Optical, electronic, thermal properties and failure mechanisms. Basic aspects of sustainability, life cycle assessment and recycling. C. Materials for energy saving. Composite and nanocomposite materials. Main types of composite materials. Molds and reinforced media different types. The role of interface in nanocomposite materials. Materials production and processing. Mechanical properties and failure mechanisms. D. Materials for utilization of solar energy. Photovoltaics for electricity production. Semiconductors, Photovoltaic cells and modules. Different PV technologies. Design of PV plants and technoeconomical analysis. Passive and energetic thermal solar systems for electricity production and heating/cooling applications. Optical and thermal properties of materials, E. Materials for utilization of wind potential. Wind power and basic wind properties. Main types of wind turbines and mechanical and aerodynamic properties of materials used as components. Design of wind plants and techno-economic analysis. F. Steam engines for electricity production. Principles of operation, energy balance and Rankine cycle. Materials used as components of steam engines, basic properties and failure mechanisms. Application of steam engines for electricity production from fossil fuels, geothermal energy and biomass	
Recommended literature	1. Materials in Energy Conversion, Harvesting, and Storage, 1st edition; Authors: Kathy Lu, Print ISBN: 9781118889107	
	2. Renewable energy [electronic resource], 3rd edition; Authors: Sorensen, Bent, ISBN: 0126561532	

Teaching and learning methods	**LECTURES**	**RECITATION**	**LAB/PRACTICE**	**PROJECT / HOMEWORK**
	3 h/w	0 h/w	0 h/w	1/semester

Assessment type[9]	Combined
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 present their project and deliver a 10 pages summary of the project 2. Final written exams (50 % of final grade)
Instruction Language	Greek
Erasmus availability	YES
Module URL	https://eclass.upatras.gr/courses/CMNG2197/
Last Amendment	December 2016

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