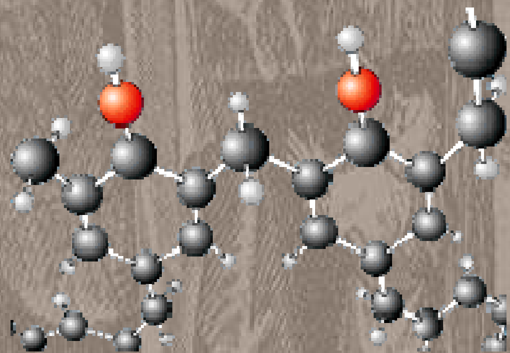
ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΑΤΡΩΝ
UNIVERSITY OF PATRAS

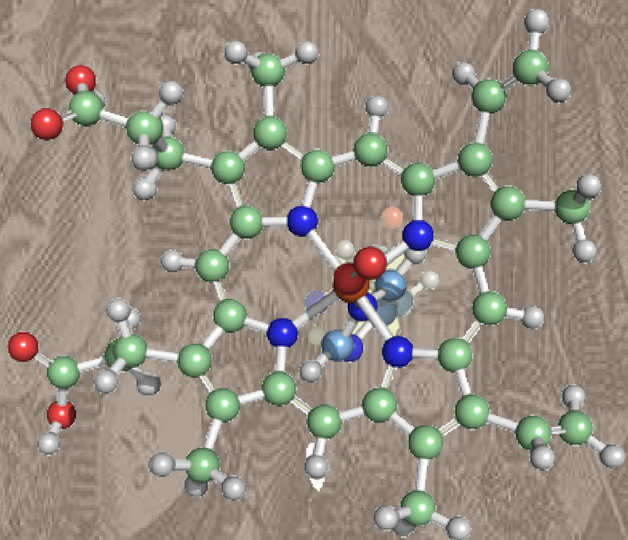
University *of* Patras



Department *of* Chemistry

Curriculum

2017-2018



http://www.chem.upatras.gr
Patras, Greece

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I. GENERAL INFORMATION-
STRUCTURE OF THE DEPARTMENT

I.1 The Department – An Overview

The Department of Chemistry was founded in 1966 and is one of the first established Departments of the University of Patras. The educational and research activities of the Department are centered in three separate buildings (North, South and the New Chemistry Buildings), where research and undergraduate training laboratories, one computational center and a library are located.

The Faculty of the Department consists of 33 Academic Staff members, and 9 members of Special Teaching and Technical Personnel. About 700 undergraduate and over 200 postgraduate students are currently enrolled.

The Department collaborates with many European Universities under the Erasmus Student and Academic Staff Exchange Program), at both undergraduate and postgraduate levels (https://www.upatras.gr/en/erasmus). Moreover, the majority of the faculty members participate in joint research projects with scientists from other Academic and Research Institutions and industries in Greece and abroad.

The Department is organized into the following three Divisions, each consisting of specialised laboratories with extensive research facilities and instruments:

- Division of Organic Chemistry, Biochemistry and Natural Products.
- Division of Physical, Inorganic and Nuclear-Radiation Chemistry.
- Division of Applied, Analytical and Environmental Chemistry.

I.2 UnderGraduate Studies

The Department of Chemistry provides students with a full educational program covering a wide range of scientific areas and skills associated with chemistry (including inorganic, organic, physical, structural, and analytical chemistry), catalysis, biochemistry, biotechnology, materials, polymer, food and environmental science. The awarded diploma qualifies our graduates with significant skills to begin a career in public or private sectors, such as the chemical industry, a wide range of analytical laboratories, as well as research and educational institutions.

I.3 PostGraduate Studies

Postgraduate studies enable our students to pursue academic careers or careers in the private sector. The Postgraduate Program has two main directions:

I.3.1 Master of Science (MSc) specialisations

MSc cources are available in the following scientific areas:

- Applied Biochemistry: Clinical Chemistry, Biotechnology and Evaluation of Pharmaceutical Products.
- Synthetic Chemistry and Advanced Polymeric and Nanostructured Materials.

- Catalysis, Pollution Control and Clean Energy Production.
- Analytical Chemistry and Nanotechnology.
- Green Chemistry and Clean Technologies.

I.3.2 Doctorate (PhD) Programs

The PostGraduate Studies Program (PhD) covers all the research areas and activities of the Department of Chemistry. The PostGraduate Studies Program enrols graduates from all Departments of the Schools of Sciences and Polytechnic Institutes of Greece or corresponding Institutions abroad, such as Departments of Chemistry, Biology, Geology, Physics and Agriculture, Medicine, Pharmacology and Chemical Engineering.

I.3.3 Other MSc Programs

- Interdepartmental MSc Program **"Medicinal Chemistry: Drug Discovery and Design"**. The Departments of Chemistry, Pharmacy, and Medicine of the University of Patras participate in the program.
- Interdepartmental MSc Program **"Chemical Biology"**. The Departments of Chemistry, Pharmacy and Medicine of the University of Patras participate in the program.
- Interdepartmental MSc Program **"Environment Sciences"**. The Departments of Biology, Geology, Mathematics, Physics and Chemistry of the University of Patras participate in the program.
- Interdepartmental MSc Studies **"Polymer Science and Technology"**. The Departments of Chemistry, Chemical Engineering, Materials Science, Mechanical and Aeronautical Engineering and Physics of the University of Patras participate in the program.

I.4 Collaborating Countries & Institutions

Country	University/Institution
Belgium	Antwerp, Department of Chemistry K. Leuven, Zoological Institute Louvain, Unite de Catalyse et Chimie des Materiaux Divises
Canada	New Brunswick, Department of Chemistry
France	Strasbourg, Louis Pasteur Angers, Laboratoire de Proprietes Optiques des Materiaux et Applications Blaise-Pascal, Department of Chemical and Biochemical Engineering, LGCB Marseille, Provence-CNRS Pierre et Marie Curie, Laboratoire de Physico-chimie Macromoleculaire Pau et des Pays de 1'Adour, Laboratoire de Chimie Structurale
Germany	Hannover, Department of Natural Sciences, Institute of Food Chemistry
Italy	Bologna, Department of Chemistry Calabria, Department of Chemistry Ferrara, Department of Chemistry Florence, Departments of Chemistry and Pharmacy and Magnetic ResonanceCenter Modena and Reggio Emilia, Department of Agricultural Sciences Rome, Department of Biochemistry (La Sapienza) Varese, School of Medicine
Japan	Agriculture and Technology, Laboratory of Organic Geochemistry (Tokyo)
Norway	Bergen, Department of Chemistry
Poland	Adam Mickiewicz, Institute of Physics, Nonlinear Optics Division
Spain	Barcelona, Department of Inorganic Chemistry
Sweden	Stockholm, Karolinska Institute
The Netherlands	Leiden, Department of Chemistry
Turkey	Mersin, Department of Environmental Engineering
United Kingdom	Cardiff, Department of Chemistry Imperial College London, Department of Chemical Engineering and Chemical Technology London, Birkbeck College Manchester, School of Chemical Engineering and Analytical Science & Satake Centre for Grain Process Engineering Newcastle, Civil Engineering and Geosciences Ulster, School of Biomedical Sciences Reading, Department of Food Biosciences
USA	Oklahoma, Civil Engineering and Environmental Science Pensylvania School of Medicine
Australia	Burnet Research Institute, Melbourne
Bulgaria	Catalysis, Bulgarian Academy of Sciences
Germany	Max-Planck, Institut für Polymerforschung TU Braunschweig, Institut für Physikalische und TheoretischeChemie
Hungary	Isotope and Surface Chemistry, Chemical Research Centre, HAS, Budapest
India	National Institute for Interdisciplinary Science & Technology, Biotechnology Division (NIIST)
Slovenia	National Institute of Chemistry, Ljubljana
Spain	Consejo, Superior de Investigaciones Cientifıcas, Catalysis & Petrochemistry (CSIC)
Sweden	Karolinska Institute (Stockholm) Ludwing Institutte for Cancer Research (Uppsala) Kungliga Tekniska Högskolan, Stockholm

II. UNDERGRADUATE STUDIES PROGRAM

II.1 General Information

Each academic year is divided into two semesters. The first (Autumn) semester begins around October 1 and ends around January 31. Classes for the second (Spring) semester start around February 16 and end around June 10. The exact dates are announced at the beginning of each academic year in the departmental website: www.chem.upatras.gr. In order to graduate, that is to obtain the Diploma (Greek: "*Ptychio*") in Chemistry, the completion of 8 semesters (4 years) is formally required. During each semester, a student has to follow 4-6 courses with a total of 23-30 contact hours per week.

II.1.1 Courses

A course may consist of lectures, lectures and seminars, or lectures, seminars and practical excersice (laboratory). The courses offered in the Department of Chemistry are grouped within the two semesters (Autumn and Spring). The way these courses appear in the Course Table, indicate the optimum sequence of courses (model study plan) that a student should follow.

The Curriculum consists of compulsory, semi-optional, and freely optional (chemistry or non-chemistry) courses that can be chosen by the students according to their special interests. These courses are presented in the Course Table as Optional (Elective) or Semi-Optional Courses. The minimum and maximum number of courses each student should opt for is also indicated therein. These Optional and Semi-Optional courses are then treated as Compulsory ones in relation to attendance and exams matters. There are no specific quotas of students that have to attend these courses. However, in some cases, a course may be suspended, when less than three students have selected it. Students are then advised to apply for a different course. The number of students usually participating in Optional courses is around 10-20 students. This number may also be higher. These courses provide some sort of specialization that is considered important for the job market and are related to the Chemistry of Foods & Beverages, Oenology, Environmental Chemistry, Polymer Chemistry, Analytical Chemistry, Organic and Inorganic Chemistry and Clinical Chemistry. Lectures and seminars can be followed by students at will, whereas attendance of laboratories is mandatory.

II.1.2 Exams/Assesment

There is no formal assessment throughout the semester for most courses. In some cases, lecturers offer midterm evaluation-type exams within the semester with the grades obtained taken into account in the final mark. Moreover, the students are constantly examined, during the laboratory training, usually orally, on the theory and practice of each experiment they are about to perform. Finally, they have to present a written report of their results after the end of each experiment. All these are taken into account in the final mark, together with the marks of the final written examination, associated with each particular laboratory.

Courses are normaly offered in the Greek language. Lecturers teach the related material based on Greek textbooks. Greek students study from these textbooks, which are offered free by the Greek State. These textbooks are usually translations of the corresponding, most broadly used, English textbooks. Thus, the content and the level of these Greek textbooks are similar to the corresponding English ones. So, a corresponding English textbook is indicated from the Lecturer to an ERASMUS student whose native language is not Greek and his/her Greek is not good enough to be able to study from a Greek textbook or follow lectures and seminars. These textbooks can be borrowed from our Departmental or Institutional (Central) Library.

A course is considered successfully passed, when the student has acquired at least the grade 5 out of 10 in the associated exams. A course that includes laboratory training requires a passing grade for both. Exams are conducted at the end of each semester (3 weeks duration), while repeat exams (4 weeks duration) take place in September. However, students who have failed in these exams, or have not participated in some, can be freely re-examined in the following exam periods.

II.1.3 UnderGraduate Diploma Project

During their final year, students have to carry out a short research project, assigned in Greek as "Experimental Undergraduate Diploma Project", under the supervision of a member of the Academic staff, in addition to the courses they have to follow. At the end this project, they are expected to provide a Diploma Thesis (a written report of their results) and give an oral presentation. A grade is then assigned to the student by the supervisor involved, reflecting the overall performance of the student. This grade should be at least 5 out of 10 for a successfully completed "Experimental Undergraduate Diploma Project". A part or the whole of this project can also be conducted in another research laboratory in the same or another University. A student is considered to have completed his/her studies in our Department, only when he/she has passed all the exams associated with all courses and has trained successfully in the associated laboratories described in the Curriculum.

II.1.4 Greek Credits

The number of Greek credits assigned to each course is dictated by a regulation of the Greek Law for Higher Education (No. 1268/82) which states that 1 Greek credit corresponds to 1 hour lecture per week per semester, whereas for the rest of educational work (e.g., seminars and labs) 1 credit corresponds to 1-3 hours per week per semester. Through its General Assembly, each Department defines the number of credits assigned to this other educational work. In our Department, 1 credit corresponds to 1 hour per seminar per week per semester and 2 hours lab work per week per semester. 20 Greek credits are assigned to the Experimental Undergraduate Diploma Project. According to this definition, ca. 20 Greek credits are associated with each semester. The credits collected by the students during their study period in the Greek Universities, and their corresponding grades, are taken into account for the calculation of their final mark. A new factor, called "weighing" factor, has been introduced by law for the forementioned calculation. According to this factor, courses associated with 1-2 Greek credits have a factor of 1.0, courses associated with 3-4 Greek credits have a factor of 1.5 and courses with more than 4 credits take the highest possible factor of 2.0. The final graduating grade is calculated based on the grades of all courses and the associated weighing factors.

II.1.5 ECTS Credits

Moreover, taking into account the regulation for the higher education system as it was briefly described above, the basic requirement of the ECTS system (European Course Credit Transfer System) for 30 credits for each semester was met in our Department. These credits were then allocated to each course of a semester taking into consideration the conduct hours for each course and the other work-load the mean student is expected to consume in other activities (private studying, preparation of reports, participation in exams, etc.) so that he/she will complete successfully each course. The credits were assigned to courses as multiples of 5 throughout the curriculum (according to the ECTNA recommendations for the ''Eurobachelor''), that is 5 or 10 depending on whether they include laboratory work or not. In the revised curriculum, which started operating since academic year 2015-16 and is currently in its second year of implementation, this is however valid only for the core courses (Inorganic Chemistry, Organic Chemistry, Analytical Chemistry and Physical Chemistry as well Biological Chemistry, Chemical Technology and Food Chemistry), the Semi-optional courses and the courses supporting them (Mathematics, Physics, Biology and Chemistry and Informatics). For the freely Optional Chemistry Courses, 4 ECTS credits are assigned and 3 ECTS credits are assigned to the freely Optional non-Chemistry Courses.

II.1.6 ERASMUS students

An ERASMUS student, who has studied for at least one year in our Institution, can be considered as legitimate to obtain the Diploma (*Ptychion*) in Chemistry offered by our Department for undergraduate studies. The ERASMUS Committee of our Department will consider the studies records of students abroad and their performance at our Department. Courses successfully completed abroad will then be correlated to those of the University of Patras. If there is no need for additional courses, this committee will propose to the General Assembly of the Department to award the Diploma (*Ptychion*) to that particular student. Otherwise, the student will have to attend and successfully pass all those courses which are required to complete our Curriculum.

Following graduation, it is possible for a student to follow graduate studies leading to either a Postgraduate Diploma of Specialization (PDS, equivalent to MSc Diploma) or a Doctorate Diploma (DD that is a PhD Diploma). The PDS involves 1.5 years of studies. The candidate follows during the first year ca. 4-8 courses in total (2-4 courses each semester) and has to pass the exams associated with these courses. Exams take place at the end of each semester (1 week duration). The minimum passing grade is 5 out of 10. Repeat exams for both semesters take place in September (2 weeks duration). In addition, the student has to prepare and deliver two oral presentations (at the end of each semester or the end of second semester), related to the specialization courses. During their third semester, students carry out a short, novel, research project and present their results written and orally. There are currently five Postgraduate Programs available in the Department and four other Interdepartmental Postgraduate Programs in which our Department participates.

II.2 Types of Courses and Associated ECTS Credits

II.2.1 Core (Compulsory) Courses

COURSE	ECTS CREDITS
Inorganic Chemistry	30
Organic Chemistry	35
Physical Chemistry	30
Analytical Chemistry	30
Biochemistry	15
Physics for Chemists	5
Mathematics for Chemists	5
Chemistry and Informatics	5
General Biology	5
Chemical Technology-1 (Principles-Physical and Chemical Processes)	10
Food Chemistry	5
Total number of ECTS credits	***170***

II.2.2 Semi-Optional Courses*

COURSE	ECTS CREDITS
Chemical Technology-2 (Special Topics of Physical Processes)	5
Materials Chemistry and Technology (Polymers, Nanomaterials, Colloids, Catalysts)	5
Environmental Chemistry	5
Computational Chemistry	5
Structural Chemistry	5
Principles and Applications of Nuclear Chemistry	5
Heterocyclic Chemistry and Principles of Pharmaceutical Chemistry	5
Total number of ECTS credits	***25 (out of 35)***

* *The remaining courses (corresponding to 10 ECTS courses), which were not selected as Semi-Optional ones, can be selected as Elective Chemistry Courses.*

II.2.3 Experimental Dimploma (Bachelor) Thesis *

COURSE	ECTS CREDITS
Experimental Undergraduate Diploma Project	20

* *In special cases, the Bachelor Thesis may be replaced by writing an extended review on a chemical theme (in the form of a review article). 5 ECTS Credits are assigned to such a theoretical thesis. The remaining 15 ECTS credits will be then substituted by additional Semi-Optional or Elective chemical modules.*

*II.2.4 Optional (Elective) Chemistry Courses**

COURSE	ECTS CREDITS
NMR Spectroscopy, Molecular Modeling and Design	5
Synthetic Organic Chemistry	5
Organic Industrial Products and Green Chemistry	5
Chemistry of Organometallic Compounds and Mechanisms of Inorganic Reactions	5
Bioinorganic Chemistry	5
Introduction to Molecular Design	5
Special Topics of Physical Chemistry	5
Quality Control in Analytical Chemistry	5
Catalysis	5
Food Biochemistry	5
Clinical Chemistry	5
Biochemistry-3 (Gene Expression and Regulation-Gene Engineering)	5
Polymer Science	5
Food Chemistry and Technology – Oenology I	10
Chemical Industries (Inorganic and Organic)	5
Food Chemistry and Technology – Oenology II	5
Renewable Energy Sources and Chemical Storage	5
Biotechnology	5
Industrial Placement	5
***2-3 courses to be selected with a total number of ECTS credits**	***15***

*II.2.5 Optional (Elective) Non-Chemistry Courses**

COURSE	ECTS CREDITS
Microbiology	5
Didactics of Natural Sciences	5
European Language (one from: French, Spanish, German, Italian)	5
Business Administration	5
Economics	5
English Chemical Terminology	5
Viticulture	5
Enzymology	5
***2 courses to be selected with a total number of ECTS credits**	**10**

III. PROGRAM PLAN

III.1 UnderGraduate Studies

The four numerals, following each course code number, indicate lecture hours, tutorial hours, laboratory hours and number of ECTS credits, respectively. During the fourth year of studies, the students have to carry out a short research project (VII and VIII semesters) and finally submit a Diploma Thesis. 20 ECTS credit units are assigned to this research work (Diploma Project), which is performed under the supervision of a faculty member. In special cases, the Bachelor Thesis may be replaced by writing an extended review on a theme related to chemistry (in the form of a review article). 5 ECTS Credits are assigned to this Thesis. The remaining 15 ECTS credits will then be replaced by Semi-Optional or Elective chemictry modules.

III.2 Department of Chemistry Curriculum – Applied in 2016-2017

Abbreviations:

Abbr.	*Greek abbr.*	*Description*
Math		*Mathematics*
Phys		*Physics*
InCh		*Inorganic Chemistry*
OrCh		*Organic Chemistry*
AnCh		*Analytical Chemistry*
BiCh		*Biochemistry*
ChIn		*Chemistry and Informatics*
PhCh		*Physical Chemistry*
Biol		*Biology*
FoCh		*Food Chemistry*
ChTe		*Chemical Technology*
InPl		*Industrial Placement*
DiTh		*Experimental Diploma Thesis*
CH		*Contact Hours*
LC	**Δ**	*Lectures*
SE	**Φ**	*Seminars*
LB	**E**	*Laboratory Exercises*

Note: All course codes should be prefixed with the classification code G-LSUD [Greece-Long Studies, University (at least three years) finishing with an academic Degree].

A specific code course corresponds to every chemistry course which is consisted of four letters and three numerals. The letters form actually some kind of abbreviation of the full name of each course whereas from the three numerals the first shows the indicative semester the course is being taught and the other two the particular subject area and the serial number of the particular course within the specific subject area as follows:

01-09: Organic Chemistry
10-19: Biochemistry (Biological Chemistry)
20-29: Inorganic Chemistry
30-39: Physical Chemistry
40-49: Nuclear-Radiation Chemistry
50-59: Analytical Chemistry
60-60: Structural Chemistry
70-79: Materials Chemistry, Polymers, Food Chemistry
80-89: Chemical Technology, Industrial Chemistry
90-99: Catalysis, Environmental Chemistry.

For example, the course OrCh405 is a Chemistry Course, which is recommended to be followed by a student in the 4th semester (spring semester of the 2nd year of studies), and actually it is the 4th course of Organic Chemistry.

To each Non-chemistry Course the course code is also consisted of four letters and three numerals. The letters are indicative of the scientific field of the course, the first numeral shows the semester the course is being taught and the last two numeral shows the particular scientific filed as follows:
01-09: Mathematics
10-19: Physics
20-29: Biology (e.g. 20=General Biology, 21=Microbiology, 22=Viticulture)
30-39: Economy (e.g. 30=Economy, 31=Business Management)
40-49: Humanities (e.g. 40=Didactics of Natural Sciences, 41=English Chemical Terminology, 42=French, 43=German, 44=Spanish, 45=Italics).

For example, the course Biol120 is the first non-chemistry course of Biology which is taught in the 1st semester (winter semester of the 1st year of studies), whereas the course MiBi321 is the 2nd course of Biology (Microbiology) and is recommended to the student to be followed in the 3rd semester (winter semester of the 1st year of studies).

The courses are only taught in the indicative semesters (winter or spring) according to the following Study Plan.

It should be noted that there are currently two study plans run in the Department. The first two years concern the student who started their studies in the academic years 2016-17 and 2017-18, whereas the last two years concern students who started their studies in academic years earlier than 2016-17.

1st Semester (I) (applied since 2016-17)

COURSE			CONTACT HOURS (CH)			ECTS credits
Code in English	Code in Greek	Title	Lectures (LC)	Seminars (SE)	Laboratory (LB)	
Math101	CHE_MA 101	Mathematics for Chemists	4	1	1	5
Phys111	CHE_PH 111	Physics for Chemists	4	1	0	5
InCh121	CHE_XA 127	Introduction to Inorganic Chemistry	3	1	1	5
OrCh101	CHE_XO 101	Structure, Reactivity and Mechanism in Organic Chemistry	3	1	0	5
ChIn131	CHE_XA 131	Chemistry and Informatics	2	0	2	5
Biol120	CHE_BI 121	General Biology	3	1	0	5
Total (28 CH)			**19**	**5**	**4**	**30**

2nd Semester (II) (applied since 2016-17)

COURSE			CONTACT HOURS (CH)			ECTS credits
Code in English	Code in Greek	Title	Lectures (LC)	Seminars (SE)	Laboratory (LB)	
InCh222	CHE_XA 222	Inorganic Chemistry-1 (Chemistry of the Representative Elements)	3	1	3	10
PhCh232	CHE_XA 232	Physical Chemistry-1	3	1	0	5
AnCh251	CHE_XE 251	Analytical Chemistry-1	3	1	4	10
OrCh202	CHE_XO 202	Organic Chemistry of Functional Groups-I	3	1	0	5
Total (23 CH)			**12**	**4**	**7**	**30**

3rd Semester (III) (first applied in 2017-18)

COURSE			CONTACT HOURS (CH)			ECTS credits
Code in English	Code in Greek	Title	Lectures (LC)	Seminars (SE)	Laboratory (LB)	
AnCh352	CHE_XE 352	Analytical Chemistry-2	2	0	5	5
InCh323	CHE_XA 323	Inorganic Chemistry-2 (Chemistry of 1st Row Transition Metals and of Coordination Compounds)	3	1	3	10
PhCh333	CHE_XA333	Physical Chemistry-2	3	1	0	5
AnCh353	CHE_XA 353	Instrumental Chemical Analysis-1	3	1	0	5
OrCh303	CHE_XO 303	Organic Chemistry of Functional Groups-II	3	1	0	5
Total (26 CH)			**14**	**4**	**8**	**30**

4^{th} Semester (IV) (first applied in 2017-18)

COURSE			CONTACT HOURS (CH)			ECTS credits
Code in English	Code in Greek	Title	Lectures (LC)	Seminars (SE)	Laboratory (LB)	
OrCh404	CHE_XO 404	Spectroscopy of Organic Compounds – Experimental Organic Chemistry-1	2	2	4	5
OrCh405	CHE_XO 405	Chemistry of Heterocyclic Compounds and Biomolecules	3	1	0	5
AnCh454	CHE_XE 454	Instrumental Chemical Analysis-2	3	1	3	10
PhCh434	CHE_XA 434	Physical Chemistry-3	3	1	4	10
Total (27 CH)			**11**	**5**	**11**	**30**

5^{th} Semester (V)

COURSE			CONTACT HOURS (CH)			ECTS credits
Code in English	Code in Greek	Title	Lectures (LC)	Seminars (SE)	Laboratory (LB)	
OrCh503	CHE_XO 503	Organic Chemistry of Functional Groups-II	2	2	6	10
PhCh535	CHE_XA 535	Physical Chemistry-4	3	1	4	10
BiCh510	CHE_XO 510	Biochemistry-1	3	1	0	5
InCh524	CHE_XA 524	Inorganic Chemistry-3 (Chemistry of 2^{nd} and 3^{rd} Row Metals and of Lanthanides)	3	1	0	5
Total (26 CH)			**11**	**5**	**10**	**30**

6^{th} Semester (VI)

COURSE			CONTACT HOURS (CH)			ECTS credits
Code in English	Code in Greek	Title	Lectures (LC)	Seminars (SE)	Laboratory (LB)	
OrCh604	CHE_XO 604	Introduction to Spectroscopy of Organic Compounds and to the Chemistry of Biomolecules and of Heterocyclic Compounds	3	1	0	5
BiCh511	CHE_XO 511	Biochemistry-2	3	1	4	10
FoCh670	CHE_XE 670	Food Chemistry	2	1	2	5
ChTe680	CHE_XE 680	Chemical Technology-1 (Principles-Physical and Chemical Processes)	3	3	2	10
Total (25 CH)			**11**	**6**	**8**	**30**

7th Semester (VII)

COURSE			CONTACT HOURS (CH)			ECTS credits
Code in English	Code in Greek	Title	Lectures (LC)	Seminars (SE)	Laboratory (LB)	
✓	✓	Semi-Optional Course-1	✓	✓	✓	5
✓	✓	Semi-Optional Course-2	✓	✓	✓	5
#	#	Elective Chemistry Course-1	#	#	#	5
#	#	Elective Chemistry Course-2	#	#	#	5
DiTh700	**EX 700**	Experimental Undergraduate Diploma Project-1* (literature search and initiation of laboratory project)	0	0	6	5
DiTh701	**EX 701**	Experimental Undergraduate Diploma Project -2* (continuation of laboratory project)	0	0	6	5
Total (- CH)			**-**	**-**	**-**	**30**

8th Semester (VIII)

COURSE			CONTACT HOURS (CH)			ECTS credits
Code in English	Code in Greek	Title	Lectures (LC)	Seminars (SE)	Laboratory (LB)	
✓	✓	Semi-Optional Course-3*	✓	✓	✓	5
✓	✓	Semi-Optional Course-4*	✓	✓	✓	5
✓	✓	Semi-Optional Course-5*	✓	✓	✓	5
#	#	Elective Chemistry Course-3*	#	#	#	5
DiTh800	**EX 800**	Experimental Undergraduate Diploma Project -3 * (continuation and completion of laboratory project)*	0	0	6	5
DiTh801	**EX 801**	Experimental Undergraduate Diploma Project -4 * (writing-up of thesis and public presentation of results)*	0	0	6	5
Total (- CH)			**-**	**-**	**-**	**30**

✓, # Indicative distribution of CH. For the actual distribution of CH to LC, SE and LB for each course see Table III.3.

** The research project of the Diploma Thesis is usually conducted in one of the research laboratories of the Department of Chemistry. It can also take place in part or totally in other cooperating Departments or Research Institutes or the Chemical Industry or other bodies employing chemists (e.g. Hospitals, General State Laboratory, etc.). The Experimental Diploma Thesis is always supervised by a member of the Academic staff of the Department of Chemistry who is responsible for assigning the final mark to the thesis (one combined mark for the course DiTh700 and DiTh800).*

For Erasmus students, the Experimental Diploma Thesis may take place entirely in one semester (24 LB per week, 20 ECTS credits). The remaining 10 ECTS credits can be then obtained by freely selecting one or two courses from those taught in that particular semester (winter or autumn), followed by the successful pass in the associated exams.

III.3 Grouping of Optional Courses of all Types

Optional Cources for 7th Semester

	COURSE					ECTS credits
Code in English	Code in Greek	Title	Contact hours (CH)			
			LH	TH	PH	
Semi-Optional Courses						
CtMa781	**CHE_XE781**	Materials Chemistry and Technology (Polymers, Nanomaterials, Colloids, Catalysts)	2	0	2	5
EnCh790	**CHE_XE790**	Environmental Chemistry	3	0	2	5
NuCh741	**CHE_XA741**	Principles and Applications of Nuclear Chemistry	2	0	1	5
Optional Chemistry Courses (7th Semester)						
NsMd705	**CHE_XO705**	NMR Spectroscopy, Molecular Modeling and Design	3	1	0	5
SoCh706	**CHE_XO706**	Synthetic Organic Chemistry	3	1	0	5
FcTo771	**CHE_XE771**	Food Chemistry and Technology – Oenology I	4	0	4	10
CoMi725	**CHE_XA725**	Chemistry of Organometallic Compounds and Mechanisms of Inorganic Reactions	4	0	0	5
StPc736	**CHE_XA736**	Special Topics in Physical Chemistry	3	1	0	5
QcAc755	**CHE_XE755**	Quality Control in Analytical Chemistry	3	1	0	5
CaTa791	**CHE_XE791**	Catalysis	4	0	0	5
GeRe712	**CHE_XA712**	Biochemistry-3 (Gene Expression and Regulation-Gene Engineering)	3	1	0	5
ClCh713	**CHE_XA713**	Clinical Chemistry	2	0	2	5
InPl 785	**CHE_XΠ785**	Industrial placement	0	0	8	5

Optional Cources for 8th Semester

	COURSE					ECTS credits
Code in English	**Code in Greek**	**Title**	**Contact hours (CH)**			
			LH	**TH**	**PH**	
Semi-Optional Courses						
ChTe882	**XE 882**	Chemical Technology-2 (Special Topics of Physical Processes)	3	1	0	5
HpCh807	**XO 807**	Heterocyclic Chemistry and Principles of Pharmaceutical Chemistry	3	1	0	5
CoCh837	**XA 837**	Computational Chemistry	2	0	3	5
StCh861	**XE 861**	Structural Chemistry	4	0	0	5
Optional Chemistry Courses						
FoBi814	**XO 814**	Food Biochemistry	3	1	0	5
InMd838	**XA 838**	Introduction to Molecular Design	3	1	0	5
BiNc826	**XA 826**	Bioinorganic Chemistry	4	0	0	5
BiTe815	**XO 815**	Biotechnology	2	0	2	5
OpGc808	**XO 808**	Organic Industrial Products and Green Chemistry	4	0	0	5
PoSc883	**XE 883**	Polymer Science	3	1	0	5
ChIn884	**XE 884**	Chemical Industries (Inorganic and Organic)	4	0	0	5
FcTo872	**XE 872**	Food Chemistry and Technology – Oenology II	4	0	0	5
ReCs893	**XE 893**	Renewable Energy Sources and Chemical Storage	4	0	0	5
InPl 785	**XΠ 785**	Industrial placement	0	0	8	5

IV. DESCRIPTION OF UNDERGRADUATE COURSES

1st Semester (I) (applied since 2016-17)

Mathematics for Chemists

1. GENERAL

SCHOOL	NATURAL SCIENCES		
ACADEMIC UNIT	CHEMISTRY		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**MA101**	**SEMESTER**	**1st**
COURSE TITLE	MATHEMATICS FOR CHEMISTS		

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	**TEACHING HOURS PER WEEK**	**ECTS CREDITS**
Lectures	4	5
Seminars	1	
Laboratory work	1	
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	General background
PREREQUISITE COURSES:	There are no prerequisite courses. However, the students should already have a satisfactory knowledge of algebra, derivatives and integrals.
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek.
IS THE COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE WEBSITE (URL)	https://eclass.upatras.gr/courses/CHEM2042/

2. LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

The aim of the course is to give to the student of the Department of Chemistry the knowledge of advanced applied mathematics that he/she needs in his/her science in the areas of differential and integral calculus of one variable and of several variables, of linear algebra, differential equations, probabilities and statistics. This knowledge is necessary and is used in many subsequent specialization courses in chemistry.In addition, by solving chemistry problems requiring knowledge of mathematics, students comprehend the usefulness of

mathematics as a tool for solving problems of their science. At the end of the course the student will have developed the following skills/competences: 1. To be able to efficiently use the differential and integral calculus, linear algebra, differential equations and statistics in the subsequent courses in his/her studies in chemistry as well as in related problems of chemical. 2. To be able to mathematically formulate problems of chemistry which make use of the above mathematical fields. 3. To be able to efficiently use the computer and computer algebra software in mathematics and chemical applications.
General Competences *Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?* *Search for, analysis and synthesis of data and information, with the use of the necessary technology* *Adapting to new situations* *Decision-making* *Working independently* *Team work* *Working in an international environment* *Working in an interdisciplinary environment* *Production of new research ideas* *Project planning and management* *Respect for difference and multiculturalism* *Respect for the natural environment* *Showing social, professional and ethical responsibility and sensitivity to gender issues* *Criticism and self-criticism* *Production of free, creative and inductive thinking* *Others*
Generally, by the end of this course the student will, furthermore, have develop the following general abilities (from the list above): *Autonomous (Independent) work* *Exercise of criticism and self-criticism* *Promotion of free, creative and inductive thinking*

3. SYLLABUS

1. Differential calculus of functions of a single variable.
2. Integral calculus of functions of a single variable.
3. Matrices and systems of linear equations.
4. Differential calculus of functions of several variables.
5. Integral calculus of functions of several variables.
6. Introduction in differential equations.
7. Introduction to Probability and Statistics.

4. TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Lectures, seminars and laboratory work face to face.
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of Information and Communication Technologies (ICTs) (e.g. powerpoint) in teaching. The major part of lectures content is uploaded on the internet, in the form of a series of ppt files, where from the students can freely download them. Tutorials with exemplary mathematical problem solving. Computer laboratory for learning Symbolic Algebra as a tool for solving Mathematical problems.
TEACHING METHODS *The manner and methods of teaching are described in detail.* *Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.*	

Activity	*Semester workload*
Lectures (4 contact hours per week x 13 weeks)	52
Seminars (1 contact hour per week x 13 weeks) - solving of representative problems;	13

The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS	techniques and theory associated to each laboratory experiment)	
	Laboratory work (1 contact hour per week)	13
	Final examination (3 contact hours)	3
	Hours of Private Study of the Student for the preparation of the Final Examination	44
	Course total	***125***
STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	1. Final written examination (70% of the final grade). 2. Laboratory examination (30% of the final grade). Greek grading scale: 1 to 10. Minimum passing grade: 5.	

5. ATTACHED BIBLIOGRAPHY

1. K.E. Papadakis, "Introduction to Mathematica", 3rdEdition. Tziolas Publications, 2010.
2. V.V. Markellos, "Applied Mathematics, Vol. II: Linear Algebra, Differential Equations". Symmetria Publications, 2000.
3. J. Koutrouvelis, "Statistics methods", Vol. I, Symmetria Publications, 1999.
4. R. E. Walpole, R. H. Myers, S. L. Myers and K. Ye, "Probability and statistics for engineers and scientists" https://drive.google.com/file/d/0B5T4JPIHf-6oSUxtZlBmd0Mxc0E/edit

Physics for Chemists

1. GENERAL

SCHOOL	NATURAL SCIENCES		
ACADEMIC UNIT	CHEMISTRY		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**PH111**	**SEMESTER**	**1st**
COURSE TITLE	PHYSICS FOR CHEMISTS		

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	**TEACHING HOURS PER WEEK**	**ECTS CREDITS**
Lectures	4	5
Seminars	1	
Laboratory work	-	
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	General Background
PREREQUISITE COURSES:	There are no prerequisite courses. The required knowledge of Advance Mathematics (Vectors-Derivatives-Integrals) will be developed during the courses in the

	case where they have not been covered (temporally) by the corresponding course of Mathematics that is taught also in the first semester.
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek. Teaching may be however performed in English in case foreign students attend the course.
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	

2. LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

At the end of this course the student should be able to:

1. Understand the fundamental principles of Physics.
2. Apply these principles in the fields of Chemistry.

Comprehend the operation of optical and electric/electronic instruments that he uses.

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology	*Project planning and management*
Adapting to new situations	*Respect for difference and multiculturalism*
Decision-making	*Respect for the natural environment*
Working independently	*Showing social, professional and ethical responsibility and sensitivity to gender issues*
Team work	*Criticism and self-criticism*
Working in an international environment	*Production of free, creative and inductive thinking*
Working in an interdisciplinary environment	*Others*
Production of new research ideas	

At the end of the course the student will have further developed the following skills/competences:

1. Ability to demonstrate knowledge and understanding of essential facts, concepts, principles and theories relating to Physics.
2. Ability to safely handle appliances and instruments of measurement/ diagnosis.
3. Ability to adopt and apply methodology for the solution of unfamiliar problems.
4. Ability to interact with others on inter or multidisciplinary problems.

Generally, by the end of this course the student will, furthermore, have develop the following general abilities (from the list above):

Production of new research ideas
Promotion of free, creative and inductive thinking
Respect to natural environment

3. SYLLABUS

OPTICS: Nature of light and laws of Geometric Optics. Image Formation. Interference of light waves. Diffraction and Polarization.

ELECTRICITY AND MAGNETISM: Electric Fields. Gauss's Law. Electric Potential. Capacitance and Dielectrics. Current and Resistance. Direct Current Circuits. Magnetic Fields. Sources of the magnetic field. Faraday's Law. Alternative Current Circuits. Electromagnetic Waves.

4. TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Lectures and seminars face to face.
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Lectures using transparencies, powerpoint presentations and multimedia.
TEACHING METHODS *The manner and methods of teaching are described in detail.* *Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.* *The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS*	see table below
STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	Final written examination. Greek grading scale: 1 to 10. Minimum passing grade: 5.

Activity	*Semester workload*
Lectures (4 contact hours per week x 13 weeks)	52
Seminars (1 contact hour per week x 13weeks) - solving of representative problems	13
Final examination (3 contact hours)	3
Hours of private study of the student for the preparation of the Final Examination	57
Course total	***125***

5. ATTACHED BIBLIOGRAPHY

1. R.A. Serway, "Physics for Scientists and Engineers", 3rd edition, Vol. II: Electricity and Magnetism, Vol. III: Thermodymics-Waves-Optics, Translation: L. Resvanis, Bookshop G. Korfiati, 1990.
2. H.D. Young, "University Physics", Vol. II: Electromagnetism-Optics-Modern Physics, Translation: E. Anastasakis, S.D.P. Vlassopoulos, E. Dris, et all, Papazisis Publications, 1994.
3. D. Halliday, R. Resnick, K.S. Krane, "Physics", Vol.: II, Translation: G. Pneumatikos, G. Peponidis, Scientific & Technological Publications Pneumatikos G.A., 2009.

Introduction to Inorganic Chemistry

1. GENERAL

SCHOOL	NATURAL SCIENCES		
ACADEMIC UNIT	CHEMISTRY		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**XA127**	**SEMESTER**	**1st**
COURSE TITLE	INTRODUCTION TO INORGANIC CHEMISTRY		

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures	3	5
Seminars	1	

Laboratory work	1	
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Field of Science (Inorganic Chemistry) and Skills Development (Experimental General and Inorganic Chemistry).
PREREQUISITE COURSES:	Typically, there are not prerequisite course.
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek. Teaching may be however performed in English in case foreign students attend the course.
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	https://eclass.upatras.gr/courses/CHEM2089/

2. LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

By the end of this course the student will be able to:

1. Use the law of conservation of mass, the significant figures in calculation, convert from one temperature scale to another, and calculate the density of a substance.
2. Write nuclide symbols, determine atomic weights from isotopic masses and fractional abundances, write an ionic formula given the ions, write the name and formula of an anion from the acid, and balance simple equations.
3. Calculate the formula weight from a formula, calculate the mass of an atom or molecule, convert moles of substance to grams and vice versa, calculate the percentage composition from the formula, calculate the mass of an element in a given mass of compound, determine the empirical formula from percentage composition, relate quantities in a chemical equation and find the limiting reactant.
4. Formulate net ionic equations, classify acids and bases as strong or weak, assign oxidation numbers, balance simple oxidation – reduction reactions, calculate and use molarity.
5. Relate wavelength and frequency of light, calculate the energy o a photon, determine the wavelength or frequency of a hydrogen atom, apply the de Broglie equation, and use the rules for the equation numbers.
6. Apply the Pauli exclusion principle, determine the configuration of an atom using the building-up principle or the period and group numbers, apply the Hund's rule.
7. Use Lewis symbols to represent ionic bond formation and write electron configurations of ions, compare ionic radii and obtain relative bond polarities, write Lewis formulas using formal charges, relate bond order and bond length, estimate ΔH from bond energies.
8. Predict molecular geometries, relate dipole moment and molecular geometry, apply valence bond theory, describe molecular orbital configurations.
9. Identify acid and base species according to the Brønsted-Lowry and Lewis concepts, decide whether reactants or products are favoured in an acid-base reaction, calculate concentrations of H3O+ and OH– in solutions of a strong acid or base.
10. Write the IUPAC name given the structural formula of a coordination compound and vice versa, decide whether isomers are possible, describe the bonding in a complex ion, predict the relative wavelengths of absorption of complex ions.

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology *Adapting to new situations* *Decision-making* *Working independently* *Team work* *Working in an international environment* *Working in an interdisciplinary environment* *Production of new research ideas*	*Project planning and management* *Respect for difference and multiculturalism* *Respect for the natural environment* *Showing social, professional and ethical responsibility and sensitivity to gender issues* *Criticism and self-criticism* *Production of free, creative and inductive thinking* *Others*

By the end of this course the student will, furthermore, have developed the following skills (general abilities):

1. Ability to solve cumulative-skills theoretical and practical problems. These problems require two or more operational skills earnt in the present or in previous chapters.
2. Skills enabling the student to solve simple and complex stoichiometry problems.
3. Ability to apply the key relations between position of the elements in the periodic table, their electron configuration and their physical and chemical properties.
4. The "heart" of the course is the chemical bond and the student should be able to determine the type of bonding in each substance and to describe the formation of bonds in various substances.
5. Ability to explain some important properties of compounds, as solubility, melting point, boiling point, vapor pressure and so on.
6. Developing the ability to explain magnetic properties, color and geometry of complexes and to decide whether isomers are possible. Finally, the student should be able to give some examples of applications of complexes in our daily life.

Generally, by the end of this course the student will, furthermore, have develop the following general abilities (from the list above):

Searching, analysis and synthesis of facts and information, as well as using the necessary technologies
Adaptation to new situations
Decision making
Autonomous (Independent) work
Group work
Excercise of criticism and self-criticism
Promotion of free, creative and inductive thinking
Respect to natural environment
Work design and management

3. SYLLABUS

1.Chemistry and Measurements

Law of conservation of mass. Matter: Physical state and chemical constitution (solids, liquids and gases. Elements, compounds and mixtures). Measurements and significant figures. SI units. Derived units. Units and dimensional analysis.

2. Atoms, Molecules and Ions

Atomic theory of matter. The structure of the atom. Nuclear structure–Isotopes. Atomic weights. Periodic table of the elements. Chemical formulas–Molecular and ionic substances. Organic compounds. Naming simple compounds. Writing chemical equations. Balancing chemical equations.

3. Calculations with Chemical Formulas and Equations

Molecular weight and formula weight. The mole concept. Mass percentages from the formula. Elemental analysis: Percentages of carbon, hydrogen and oxygen. Determining formulas. Molar interpretation of a chemical equation. Amounts of substances in a chemical reaction. Limiting reactant: Theoretical and percentage yields.

4. Chemical Reactions: Introduction

Ionic theory of solutions. Molecular and ionic equations. Precipitation reactions. Acid–base reactions. Oxidation–reduction reactions. Balancing simple oxidation–reduction reactions. Molar concentration.

Diluting solutions. Gravimetric analysis. Volumetric analysis.

5.Quantum Theory of the Atom

The wave nature of light. Quantum effects and photons. The Bohr theory of the hydrogen atom. Quantum mechanics. Quantum numbers and atomic orbitals.

6. Electron Configurations and Periodicity

Electron spin and the Pauli exclusion principle. Building-up principle and the periodic table. Writing electron configurations using the periodic table. Orbital diagrams of atoms–Hund's rule. Mendeleev's predictions from the periodic table. Periodic properties (atomic radii, ionization energies, electron affinities). Periodicity in the main-group elements.

7.Ionic and Covalent Bond

Describing ionic bonds. Electron configuration of ions. Ionic radii. Describing covalent bonds. Polar covalent bonds. Electronegativity. Writing Lewis electron-dot formulas. Delocalized bonding–Resonance. Exceptions to the octet rule. Formal charge and Lewis formulas. Bond length and bond order. Bond energy. Intermolecular forces (dipole-dipole forces, London forces, van der Waals forces and the properties of liquids, hydrogen bonding.

8. Molecular Geometry and Chemical Bonding Theory

The VSEPR model. Dipole moment and molecular geometry. Valence bond theory. Description of multiple bonding. Principles of molecular orbital theory. Electron configurations of diatomic molecules of the second-period elements. Molecular orbitals and delocalized bonding.

4. TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Lectures, seminars and laboratory work face to face.
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of Information and Communication Technologies (ICTs) (e.g. powerpoint) in teaching. The lectures content of the course for each chapter are uploaded on the internet, in the form of a series of ppt files, where from the students can freely download them using a password which is provided to them at the beginning of the course.
TEACHING METHODS *The manner and methods of teaching are described in detail.* *Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.* *The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS*	(see table below)
STUDENT PERFORMANCE EVALUATION	1. Oral examination during the seminars on problems given as homework in the lectures. The mark of the seminars is added

Activity	***Semester workload***
Lectures (3 contact hours per week x 13 weeks)	39
Seminars (1 contact hour per week x 10 weeks) - solving of representative problems; techniques and theory associated to each laboratory experiment)	10
4 Laboratory Exercises (3 contact hours per 3 weeks)	12
Hours for private study of the student and preparation of home-works (4 per semester), for Introduction in Inorganic Chemistry, and reports, for the Laboratory, and preparation for the Laboratory (study of techniques and theory)	16
Final examination (3 contact hours)	3
Hours of Private Study of the Student for the preparation of the Final Examination	45
Course total	***125***

Description of the evaluation procedure *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	to the final mark only when the student secures the minimum mark of 5 in the final written examination. 2. (Optional)10-min presentation of subjects related to the courses by two-student groups. The mark of the The mark of the seminars is added to the final mark when the student secures the minimum mark of 5 in the final written examination. 3. Final written examination. Greek grading scale: 1 to 10. Minimum passing grade: 5.

5. ATTACHED BIBLIOGRAPHY

1. N. Klouras, "Modern General Chemistry", 1η Edition, Greek Language Tranlsation of D.D. Ebbing και S.D. Gammon "General Chemistry", 10th Edition 2013
2. D.D. Ebbing and S. D. Gammon, "General Chemistry", 9thEdition, Houghton Mifflin Company, 2009.
3. R.H. Petrucci, W.S. Hawood, G.E Herring and J. Madura,"General Chemistry: Principles and Modern Applications", 9th Edition,Prentice Hall, 2006.
4. R. Chang, "General Chemistry: The Essential Concepts", McGraw-Hill Science Engineering, 2007.
5. T.E. Brown, E.H. LeMay and B.E. Bursten,"Chemistry: The Central Science", 10th Edition, Prentice Hall, 2006.
6. J. McMurry, R.C. Fay and L. McCarty, "Chemistry", 4th Edition, Prentice Hall, 2003.
7. S.S. Zumdahl, "Chemistry", 7th Edition, Houghton Mifflin College Div., 2007.

Structure, Reactivity and Mechanism in Organic Chemistry

1. GENERAL

SCHOOL	NATURAL SCIENCES			
ACADEMIC UNIT	CHEMISTRY			
LEVEL OF STUDIES	UNDERGRADUATE			
COURSE CODE	**XO 101**	**SEMESTER**	**1st**	
COURSE TITLE	STRUCTURE, REACTIVITY AND MECHANISM IN ORGANIC CHEMISTRY			
INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*			**TEACHING HOURS PER WEEK**	**ECTS CREDITS**
Lectures			4	5
Seminars				
Laboratory work				
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).				
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Field of Science (Organic Chemistry)			
PREREQUISITE COURSES:	There are not prerequisite courses because this course is the first one of a series of Organic Chemistry undergraduate courses			
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek. The course can be, however, taught in English in case foreign students attend the course.			
IS THE COURSE OFFERED TO	YES			

ERASMUS STUDENTS	
COURSE WEBSITE (URL)	http://www.soclab.chem.upatras.gr (→ Education → Teaching material → Structure, Reactivity and Mechanism in Organic Chemistry)

2. LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

By the end of this course the student will be able to:

Structure of organic compounds

Describe the bonds involved in organic compounds with C-C or C-heteroatom single or multiple and conjugated bonds and their influence on the geometry and the reactivity of the system.

Nomenclature of the main classes of organic compounds

Know the correct names (prefixes and suffixes) of the common functional groups. Given a structure or a condensed formula, use the IUPAC nomenclature to name correctly alkanes with a linear or branched chain, monocyclic alkanes, benzene, naphthalene, simple aromatic compounds and their simple substituted derivatives. Given an IUPAC name for any of the above-mentioned compounds, to draw correctly their structure.

Use the priority rules to determine the configuration, to identify and name correctly isomers of compounds with double bonds or rings having the E or the Z configuration or isomers [or isolated stereogenic (chiral) centers] having the R or the S absolute configuration.

Stereochemistry

Recognize a stereogenic (chiral) center in a molecular structure. Identify and distinguish between identical molecules, enantiomers and diastereomers from their structural representations. Recognize a meso-compound from its structure. With or without the use of molecular models, represent the three-dimensional structure of a molecule using «wedge bonds» or the conventions of the Newman and Fischer projections. Describe methods for the analysis of racemic mixtures. Recognize the stereochemical congestion between neighboring groups in bonds or across rings. Correlate the dynamic energy with the dihedral angle during rotation around bonds and account for the selection of a favorable conformation. Correlate *cis* and *trans* substituents in cyclohexane rings with their axial or equatorial arrangement. Use the known stereochemistry of a reaction to predict the outcome of reactions on saturated centers, double bonds and cyclohexane rings. Use the products of a reaction to identify stereochemical pathways of reactions.

Reactions and Mechanisms

Classify a given chemical transformation as addition, elimination, substitution, condensation, rearrangement, solvolysis, oxidation, reduction as well as subject to base or acid catalysis. Use the principle of the functional group to predict the chemical behavior of a given molecule. Indicate the polarization caused by the electronegativity of atoms in a given molecule and use it to predict the direction of heterolysis, the basic or acidic properties, and the electrophilic or nucleophilic properties or positions of electrophilic or nucleophilic attack.

Distinguish between a transition state (activation complex) and a reactive intermediate. Under defined reactions conditions, recognize reagents as electrophiles or nucleophiles. Given the starting materials (substrates), reagents and reaction conditions, suggest the outcome of a reaction and given or not the products, suggest a possible mechanism for the progress of the reaction with the use of "curved arrows" to show the electron movements. Explain the different stability of the reactive intermediates involved and the influence of this stability in the reaction progress.

Nucleophilic displacement

Given the reactants (a) identify the nucleophilic and electrophilic center, and the leaving group, (b) decide (if possible) whether $S_N1$or S_N2 reaction will be followed, (c) predict the structure of the products, (d) suggest how changes in the reaction conditions or the reactants would affect the outcome of the reaction, (e) decide whether or not the reaction will take place, and (f) comment on the relative S_N reaction rates. Suggest the best reagents and reaction conditions to carry out a given transformation. Use curved arrows and diagrams of reaction progress to show the mechanism of S_N1 and S_N2 reactions.

Elimination

Given the substrate, the reagent and the reaction condition, (a) predict the structure of the product(s), indicating the stereochemistry wherever this is necessary, (b) predict which elimination product will be the main wherever more than one may be formed, (c) predict whether substitution or elimination will be the main reaction (d) explain how the conformation and the configuration of a substrate can affect the outcome of an elimination reaction. Use curved arrows and diagrams of reaction progress to show the mechanism of E1 and E2 reactions.

Addition

Given the reactants (a) predict the structure of the product, indicating its stereochemistry and (b) predict which adduct will be the main product, whenever more than one can be formed. Explain why the selection of a reagent can determine the orientation of addition. Specify the reagents and the conditions required for the formation of a given product in an addition reaction.

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology	*Project planning and management*
Adapting to new situations	*Respect for difference and multiculturalism*
Decision-making	*Respect for the natural environment*
Working independently	*Showing social, professional and ethical responsibility and sensitivity to gender issues*
Team work	*Criticism and self-criticism*
Working in an international environment	*Production of free, creative and inductive thinking*
Working in an interdisciplinary environment	*Others*
Production of new research ideas	

By the end of this course the student will, furthermore, have develop the following skills (general abilities):

1. Ability to exhibit knowledge and understanding of the essential facts, concepts, theories and application which are related to Organic Chemistry.
2. Ability to apply this knowledge and understanding to the solution of problems related to Organic Chemistry of non-familiar nature.
3. Ability to adopt and apply methodology to the solution of non-familiar problems.
4. Study skills needed for continuing professional development.
5. Ability to interact with others in chemical or of interdisciplinary nature problems.

Generally, by the end of this course the student will, furthermore, have develop the following general abilities (from the list above):

Searching, analysis and synthesis of facts and information, as well as using the necessary technologies
Adaptation to new situations
Decision making
Autonomous (Independent) work
Exercise of criticism and self-criticism
Promotion of free, creative and inductive thinking

3. SYLLABUS

1. Organic Chemistry - Organic compounds

- What is Organic Chemistry
- Sources of organic compounds
- Properties of organic compounds and their significance in living organisms
- Organic compounds and Chemical Industry

2. Nomenclature of main homologous series of organic compounds

- Homologous series – Functional groups
- Rules for naming open-chain and cyclic organic compounds and applications
- Naming of organic compounds with many functional groups – Priorities of main functional groups
- Nomenclature of aromatic compounds
- Common or trivial names of very common organic compounds (simple alkenes, alkynes, alcohols, aldehydes and ketones, carboxylic acids and derivatives thereof, and aromatic and heterocyclic compounds)

3. Bonds in Organic Chemistry

- Ionic and covalent bonds
- Periodic Table and the Octet Rule
- Examples of electronic octets with transfer (ionic bonds) and with sharing (covalent bonds) electrons
- Ποσοτικοποίηση της ικανότητας των στοιχείων να δίνουν ή να αποδέχονται ηλεκτρόνια -Δυναμικό Ιονισμού και Ηλεκτρονική Συγγένεια
- Polar covalent bonds - Dipole moment - Inductive effect
- Electron repulsion and shape of molecules
- Lewis structures - Rules - Applications
- Kekulé structures
- Resonance structures
- Conventions for drawing organic compounds - Condensed Kekulé structures
- The Quantum-Mechanical description of atoms - Atomic orbitals (s, p, d) - Electron configurations of atoms - Pauli's Principle - Hund's Rule- Aufbau Principle - Configurations of closed cell or closed layer (configurations of electron duet and octet)
- Bond types
- Localized chemical bond - covalent bond
- Molecular orbitals in diatomic molecules (bonding and antibonding orbitals)
- Molecular orbitals in multi-atom molecules – hybrid orbitals - hybridization (sp, sp^2 and sp^3 hybrid orbitals)
- The molecular structure (lengths, angles and strengths of bonds) of methane, ethane, propane, H_2O, NH_3, methanol, methanamine, ethylene and acetylene
- The relationship of number of bonds and bond length and strength
- The relationship of hybridization of C atom and bond length, angle and strength
- C-C bonds in small rings (three-membered - cyclopropane)
- Multiple bonds C-Heteroatom (Double bonds C=O and C=N and triple bond C≡N
- Delocalized chemical bonds – Resonance effect – Canonical structures (forms) – Resonance hybrid – Conjugated systems – Hyperconjugation effect
- The bonds in the allylic system, 1,3-butadiene and 1,3,5-hexatriene, benzene, and the heteroaromatic systems (pyridine, pyrrole, thiophene and furan) with the Method of Molecular Orbitals
- Electronic effects (Inductive, Resonance) - Methodology for drawing resonance - Stereochemical effect
- Bonds weaker than covalent - van der Waals forces [dipole-dipole, induced or temporary dipole - induced or temporary dipole (London forces)] - Hydrogen bond

4. Structure of Organic Compounds-Stereochemistry

- Stereochemistry - Isomerism - Isomers - Constitutional isomers - Regioisomers - Double bond equivalents - Stereogenic (chiral) centre - Chiral molecule
- Configuration - Stereoisomers - Stereoisomerism - Geometrical isomerism - Optical isomerism - Nomenclature system Cahn-Ingold-Prelog (C-I-P) - Geometrical isomerism (E- and Z-geometrical isomers) and examples of alkene nomeclature - Absolute configuration - Enantiomers - Diastereomers -

Meso isomers - Achiral compounds - Examples of determining isomers - Molecular models - Skeletal models - Space-filling models - ball and stick models - Examples of molecular models - Determination of configuration on the basis of C-I-P rules (*R*- and *S*-configuration) - Methodology for determining configurations and examples - Optical isomerism and optical activity - Specific rotation - Optical purity - Enantiomeric excess (ee) - Representation of stereoisomers - Stereochemical structures - Fischer projections - zig-zag structures - Sawhorse representations - Newman projections - Interconversions of the different structural types - Molecules with one stereogenic centre - Enantiomerically pure compounds - Racemic mixtures (racemates) - Racemization - Analysis of racemates - Molecules with more than one stereogeniccentres - Enantiomers - Relative configuration - Diastereomers (*erythro*-, *threo*-, *syn*-, *anti*-) - Epimers - Meso structures - Molecular asymmetry (allenes, spiranes) - Molecules with heteroatom stereogeniccentres (chiral amines and phosphines and chiral sulfoxides) - Walden inversion

- Conformation - Conformers (or rotamers) - Conformational effects - Conformations of open-chain molecules (ethane, propane, butane) - Eclipsed conformation - Staggered conformation - Tortional angle - Tortional strain - Diagrams depicting dynamic energy variation with tortional angle - Stereochemical congestion - Stereochemical strain - Stereochemical hindrance - Conformation analysis - *syn-periplanar* and *anti-periplanar* conformations - gauche conformation - Conformations of cyclic compounds (cyclopropane, cyclobutane, cyclopentane, cyclohexane) - Angle strain - Tortional strain (or σ-bond opposition strain) - Total ring strain - Puckered conformation - Small, common-medium and large rings - Envelope conformation - Half-chair conformation - Chair conformation - Boat conformation - Twisted-boat conformation - Ring inversion - Transannular strain - Axial and equatorial bonds/substituents - 1,3-Diaxial interactions - Methodology for drawing chair conformations and axial and equatorial bonds - Chiral compounds found in Nature - Natural sources - Chiral pool - α-Amino acids - Alkaloids - Hydroxy acids - Terpenes - Carbohydrates - Asymmetric synthesis - General diagram of stereochemical relationships in organic compounds

5. Reactivity in Organic Chemistry (Reactions - Mechanisms)

- Thermodynamics of organic reactions - Free Energy Gibbs (*G*) - Enthalpy (*H*) - Entropy (*S*) – The equation $\Delta G = \Delta H - T\Delta S$ - Exergonic/Endergonic reaction – Exothermic/Endothermic reaction – Bond formation enthalpies (bond strengths) – Calculation of the ΔH of reactions – Thermodynamically/Entropically favored/unfavored reaction- Chemical equilibrium - Equilibrium (chemical) constant (*K*) – The relation between ΔG and *K* – The LeChatellier principle
- Kinetics of organic reactions – Reaction rates – Reaction mechanism – Rate constant *k*- Reaction coordinate – Acivation energy – Activation complex or Transition state – Energy barrier – Single- and multi-step reactions – Reaction intermediate – The rate-limiting step - Arrhenius equation – kinetic/thermodynamic stability – Reactions with competing steps – Kinetic versus thermodynamic control Κινητικός – Product from kinetic/thermodynamic control - Overcoming energy barriers - Reaction solvent
- Reaction mechanism – Chemical reactivity – Lewis Acids/Bases – The concept of Filicity – Types of electrophiles/nucleophiles in organic reactions – Polarizability effects – Theory of hard and soft acids and bases – The convention of curved arrows – Classes of reaction mechanisms – Polar mechanisms – Free radical mechanisms – Concerted mechanisms – Metal-mediated mechanisms ((ligand coupling reactions) – The principle of microscopic reversibility – Reaction selectivity - Chemoselective reaction/ chemoselectivity – Protection/deprotection of functional groups – Regioselective reaction/regioselectivity – Diastereoselective reaction/diastereoselectivity – Enantioselective reaction/enantioselectivity - Types of solvents (polar/non-polar/, protic/aprotic)
- Redox reactions - Oxidation number - Oxidation state - When an organic reaction is oxidation/reduction - Which organic reactions are not redox reactions

6. Acidity-Basicity

- Lowry and Brønsted theory of acids and bases - Conjugate base/conjugate acid - Chemical equilibrium constant $K_\alpha$and pK_α- Logarithmic scale of acidity
- Organic acidity - Organic acids - Table of pK_α values for common functional groups - Table of pK_α values for common protonanted functional groups - Acidity of carboxylic acids - Acidity of alcohols and phenols - Acidity of aliphatic and aromatic amines - Acidity of carbonyl compounds - Acidity of hydrocarbon - Organic basicity - Solvation effects
- Organic bases - Strong bases (organolithium compounds, amide and alkoxide anions) - Aliphatic and

aromatic amines as bases - Basicity of amides - Amidines and guanidines as bases - Basicity of heterocyclic compounds of nitrogen (pyrrole, pyridine, piperidine)

7. Reactive intermediates in Organic Chemistry

- Tri- and tetravalent reactive intermediates with central C atom - Carbocations - Carbanions - Free radicals - Carbenes
- Carbocations: Structure, factors stabilizing carbocations, generation and reactions, rearrangements
- Carbanions: Structure, carbanions from hydrocarbons, factors stabilizing carbanions, carbanions with covalent character (organometallic compounds)
- Free radicals: Structure, factors stabilizing free radicals, generation and reactions
- Carbenes: Structure, stability, generation, reactions

8. General mechanisms of organic reactions with simple examples

General mechanisms with simple examples for the following classes of organic reactions:

- Nucleophilic substitution on a saturated C atom (S_N2 and S_N1)
- Elimination reactions (E2 and E1)
- Addition reactions on C-C multiple bonds

4. TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Lectures and seminars face to face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of Information and Communication Technologies (ICTs) (powerpoint) in Lectures. Course lectures and exemplary solved problems for every chapter, in the form of ppt files, are uploaded in the internet (http://www.soclab.chem.upatras.gr), from where they can be freely downloaded using a password which is provided to the students at the beginning of the course. Seminars. Problems are solved in an exemplary way summarizing before the theory behind each problem. Communication with the students is established either through mail or through the webpage of the Chemistry Department.
TEACHING METHODS *The manner and methods of teaching are described in detail.* *Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.* *The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS*	see table below
STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work,*	1. Optionally, preparation of two home-works involving the solution of a series of organic chemistry problems by groups of two students. 10% of the mean mark of the two home-works will be added to the final mark only when in both home-works the minimum grade 5 has been obtained and in the final exam paper the students secure at least the grade 4. This option will be valid (a) ONLY when the incoming

Activity	*Semester workload*
Lectures (3 contact hours per week x 13 weeks)	39
Seminars (1 contact hour per week x 9 weeks) - solving of representative problems	9
Half-term evaluations (2, one in the middle and the other at the end of the semester, 2 contact hours each)	4
Final written examination (3 contact hours)	3
Private study time of the student and preparation for the half-term evaluations and final examination	70
Course total	***125***

clinical examination of patient, art interpretation, other *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	number of students were reduced drastically and (b) for ERASMUS student. 2. Optionally, half-term written examinations, the first one in week 7 of the semester and the second in week 14 (immediately after the end of the semester). 20% of the mean mark X for these two exams will be added to the final mark only when 3,5 <X< 5 and in the final exam the student secures at least the grade 4. It is prerequisite that the students should at least obtain the grade 4 in the first half-term examination in order to be allowed to participate in the second one. 3. Written examination after the end of the semester - final mark, unless the student participated in home-works and/or half-term examinations. In the latter case, the percentage(s) of the marks described above are added). Minimum passing grade: 5. 4. The home-works, the half-term examinations and the final written examination take place in the Greek language and for the foreign students (for example, ERASMUS students) in the English language. 5. All above described assessment activities of the progress of students concern solving problems which combine concepts and theories taught. Each problem is associated with a certain mark so that the total number of marks is equal to 10.

5. ATTACHED BIBLIOGRAPHY

1. J. McMurry, "Organic Chemistry", Translation to Greek: A. Varvoglis, M. Orfanopoulos, I Smonou, et al, University of Crete Publications, 2012.
2. L. G. Wade,Jr.,"Organic Chemistry", Translation to Greek: D. Komiotis, et al, A. Tziola and Sons Publications, 2010.
3. J. Clayden, N. Greeves, S. Warren, "Organic Chemistry", VolsI and II, Translation to Greek: G. Kokotos et al, Utopia Publications, 2017.
4. P. Sykes, "Guidbook to Mechanisms in Organic Chemistry", Translation to Greek: D. Gakis, Pneumatikos Publications, 1994.
5. D.E. Levy,"Arrow pushing in Organic Chemistry: an easy approach to understanding reaction mechanisms", Wiley-Interscience, 2011.

Chemistry and Informatics

1. GENERAL

SCHOOL	NATURAL SCIENCES		
ACADEMIC UNIT	CHEMISTRY		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**XA131**	**SEMESTER**	**1st**
COURSE TITLE	CHEMISTRY AND INFORMATICS		

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures	2	5
Seminars	-	
Laboratory work	2	

Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	General background and Skills development.
PREREQUISITE COURSES:	Typically, there are not prerequisite courses.
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek. Teaching may be however performed in English in case foreign students attend the course.
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	

2. LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

Basic skills in Computational Mathematics, Basic methodology of solving scientific problems.

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology

Adapting to new situations

Decision-making

Working independently

Team work

Working in an international environment

Working in an interdisciplinary environment

Production of new research ideas

Project planning and management

Respect for difference and multiculturalism

Respect for the natural environment

Showing social, professional and ethical responsibility and sensitivity to gender issues

Criticism and self-criticism

Production of free, creative and inductive thinking

Others

Use of computer, use of Internet

3. SYLLABUS

A. Computer architecture. Using computers, basic knowledge of the Internet. Seeking and exploring scientific information on the Internet. Data bases. Computer programming with emphasis on problems of significance to Chemistry and Physics.

B. Series. Matrix calculus. Roots of equations. Numerical integration. Langrange interpolation. Solving ordinary differential equations. Length of continuous curves. Fractals.

C. Text processing. Basic software: WinWord, Excel/Office. Introducing ORIGIN. Curve plotting and fitting. Collecting scientific information. Writing a scientific project.

D.Chemical information. Project on a subject of chemical interest (compulsory).

4. TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Lectures and laboratory work face to face.
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education,*	Use of Information and Communication Technologies (ICTs) (e.g. powerpoint) in teaching. The major part of the lectures content of the course for each chapter are uploaded on the internet, in the

communication with students	form of a series of ppt files, where from the students can freely download. Laboratory for Computer Programming with emphasis on problems related to the application of Mathematics to Physics and Chemistry. Draw information and scientific data from the Internet.
TEACHING METHODS *The manner and methods of teaching are described in detail.* *Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.* *The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS*	see table below

Activity	*Semester workload*
Lectures (2 contact hours per week x 13 weeks)	26
Laboratory Exercises (2 contact hours per week). Weekly training on the content of the course through applications using PC.	26
Project preparation	40
Final examination (1 contact hour)	1
Hours of Private Study of the Student for the preparation of the Final Examination	32
Course total	***125***

STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	Final written examination (90% of the final grade). Evaluation of the project (10% of the final grade). Greek grading scale: 1 to 10. Minimum passing grade: 5.

5. ATTACHED BIBLIOGRAPHY

1. H.G. Hecht, "*Mathematics in Chemistry*", Prentice Hall, 1990.
2. E.Steiner, "*The Chemistry Maths Books*", Oxford, 1996.

General Biology

1. GENERAL

SCHOOL	NATURAL SCIENCES		
ACADEMIC UNIT	CHEMISTRY		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**BI121**	**SEMESTER**	**1st**
COURSE TITLE	GENERAL BIOLOGY		

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures	3	5
Seminars	1	
Laboratory work	-	
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Field of Science (Biochemistry)
PREREQUISITE COURSES:	Typically, there are not prerequisite course.
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek. Teaching may be however performed in English in case foreign students attend the course.
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	https://eclass.upatras.gr/courses/CHEM2109/

2. LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

By the end of this course the student will be able to:

1. Recognize the basic biological functions of the cell and the molecular mechanisms underlie these functions.
2. Recognize the types of animal tissues and their embryonic origin.
3. Recognize the basic principles of the organization and functions of animal organs.

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology	*Project planning and management*
Adapting to new situations	*Respect for difference and multiculturalism*
Decision-making	*Respect for the natural environment*
Working independently	*Showing social, professional and ethical responsibility and sensitivity to gender issues*
Team work	*Criticism and self-criticism*
Working in an international environment	*Production of free, creative and inductive thinking*
Working in an interdisciplinary environment	*Others*
Production of new research ideas	

By the end of this course the student will, furthermore, have developed the following skills (general abilities):

1. Ability to demonstrate knowledge and understanding of essential facts, concepts, principles and theories related to cell biology, to the organization and functions of animal tissues and organs.
2. Ability to apply such knowledge and understanding to expand his/her education to more complex issues of general biology as to the solution of biological problems of an unfamiliar nature.
3. Study skills needed for continuing professional development.
4. Ability to interact with others on inter or multidisciplinary problems.

Generally, by the end of this course the student will, furthermore, have develop the following general abilities (from the list above):

Searching, analysis and synthesis of facts and information, as well as using the necessary technologies
Adaptation to new situations
Decision making
Autonomous (Independent) work
Exercise of criticism and self-criticism
Promotion of free, creative and inductive thinking

3. SYLLABUS

1. Principles of cellular organization. Viruses, nucleoprotein complexes, eukaryotic – prokaryotic cell, origin of the cell.
2. Principles of molecular organization Chemical bonds, biomolecules, macromolecules, organizarion of cellular structures and organelles.
3. Plasma membrane. Functions of membranes, molecular composition and organization, dynamic nature of membranes, transport through membranes.
4. Nucleus – Organization of chromosomes. Structure and organization of nucleus, morphological and functional characteristics of chromosomes.
5. Replication of DNA. Expression and regulation of genetic information. Replication of DNA. Principles of expression and regulation of the gene, transcription, structure and maturation of RNA, genetic code, translation.
6. Cytoplasmic network of membranes. Endoplasmic reticulum, Golgi, synthesis and maturation of proteins, transportation and secretion of proteins, internalization of cells, structures and macromolecules, lysosomes and cellular degradation.
7. Cytoplasmic organelles. Mitochondria and chloroplasts.
8. Cell signaling. Signaling molecules and transduction pathways.
9. Cytoskeleton – cellular motility. Organization of cytoskeleton, microtubules, microfibrils, intermediate fibrils, motility of the cells and organelles.
10. Cell growth – cellular division. Mitosis, cellular division, meiosis.
11. Animal tissues. Origin and characteristics of animal cells and tissues.
12. Animal organs. Organization and functions of animal organs.

4. TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Lectures, self-tests of students and problem-solving seminars.
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of Information and Communication Technologies (ICTs) (e.g. powerpoint) in teaching. The lectures content of the course for each chapter are uploaded on the internet, in the form of a series of ppt files, where from the students can freely download them using a password which is provided to them at the beginning of the course.
TEACHING METHODS *The manner and methods of teaching are described in detail.* *Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.* *The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS*	see table below
STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report,*	1. Optionally, two mid-term examinations with the final examination grade to be the mean mark. It is mandatory to obtain pass grade (≥5) in each examination. 2. Written examination after the end of the semester. Minimum passing grade: 5.

Activity	*Semester workload*
Lectures (3 contact hours per week x 13 weeks)	39
Seminars (1 contact hour per week x 9 weeks) - solving of representative problems	9
Mid-term examinations (2 mid-term examinations x 2 contact hours each)	4
Final examination (3 contact hours)	3
Hours for private study of the student and preparation for mid-term or/and final examination	70
Course total	***125***

oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	

5. ATTACHED BIBLIOGRAPHY

1. G.M. Cooper and R.E. Hausman. "The cell: a molecular approach" Seventh Edition 2016.
2. V. Marmaras and M. Labropoulou-Marmara, "Cell Biology: a molecular approach", 4th Edition, Typorama Edition, 2000.
3. B. Lewin, "Genes VIII", Volume I and II, (Greek edition), 8th Edition, Translation: G. Stamatogiannopoulos, Academic Editions I. Basdra, 2004.

2nd Semester (II) (applied since 2016-17)

Inorganic Chemistry-1 (Chemistry of the Representative Elements)

1. GENERAL

SCHOOL	NATURAL SCIENCES		
ACADEMIC UNIT	CHEMISTRY		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**XA222**	**SEMESTER**	**2nd**
COURSE TITLE	INORGANIC CHEMISTRY 1 (CHEMISTRY OF REPRESENTATIVE ELEMENTS)		

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures	3	10
Seminars	1	
Laboratory work	3	
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Field of Science (Inorganic Chemistry) and Skills Development (Experimental InorganicChemistry)
PREREQUISITE COURSES:	Typically, there are not prerequisite course. Essentially, the students should possess: (a) knowledge provided through the previously taught theoretical courses ''Introduction to Inorganic Chemistry'', and (b) laboratory skills obtained through the previously attended laboratory-related course"Introduction to Inorganic Chemistry".
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek. Teaching may be however performed in English in case foreign students attend the course.
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	https://eclass.upatras.gr/courses/CHEM2073/

2. LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

By the end of this course the student will be able to appreciate the fact that:

There are some ninety-two naturally occurring elements as well as a handful of man-made radioactive elements. When in combination, these elements constitute all of our food, shelter, energy sources and everything we manufacture and use in our lives. This course provides a foundation for the understanding of the varying chemistries of the elements of the Periodic Table, with emphasis on inorganic materials. The course includes the descriptive chemistry of many of the most common elements and their compounds, integrating such topics as symmetry and structure, bonding models, reactions and the synthesis and characterization of inorganic compounds. An understanding of the behavior of elements and their compounds is central to chemistry and borders the Earth and Life Sciences, as well as Engineering.

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology

Adapting to new situations

Decision-making

Working independently

Team work

Working in an international environment

Working in an interdisciplinary environment

Production of new research ideas

Project planning and management

Respect for difference and multiculturalism

Respect for the natural environment

Showing social, professional and ethical responsibility and sensitivity to gender issues

Criticism and self-criticism

Production of free, creative and inductive thinking

Others

By the end of this course the student will, furthermore, have developed the following skills (general abilities):

1. To develop expertise relevant to the professional practice of chemistry.
2. To develop an understanding of the range and chemistry of elements in the periodic table and their compounds.
3. To establish an appreciation of the role of inorganic chemistry in the chemical sciences.
4. To develop an understanding of the role of the chemist in measurement and problem solving in inorganic chemistry.
5. To provide an understanding of chemical methods employed for problem solving involving inorganic systems.
6. To provide experience in some scientific methods employed in inorganic chemistry.
7. To develop skills in procedures and instrumental methods applied in analytical and synthetic tasks of inorganic chemistry.
8. To develop skills in the scientific method of planning, developing, conducting, reviewing and reporting experiments.
9. To develop some understanding of the professional and safety responsibilities residing in working with inorganic systems.

Generally, by the end of this course the student will, furthermore, have develop the following general abilities (from the list above):

Searching, analysis and synthesis of facts and information, as well as using the necessary technologies
Adaptation to new situations
Decision making
Autonomous (Independent) work
Group work
Exercise of criticism and self-criticism
Promotion of free, creative and inductive thinking

Respect to natural environment *Work design and management*

3. SYLLABUS

1. The elements.
2. The chemical compounds.
3. The isolation of elements.
4. The life cycle of compounds.
5. How we can systematically study the elements and their compounds.
6. Introduction to the chemical, biochemical and biological properties of metals, non-metals and semi-metals.
7. Chemistry of hydrogen and its compounds.
8. Chemistry of oxygen and its compounds.
9. On water.
10. The atmosphere.
11. General aspects of the chemistry of the 1st group elements.
12. General aspects of the chemistry of the 2nd group elements.
13. General aspects of the chemistry of the 13th group elements.
14. General aspects of the chemistry of the 14th group elements.
15. General aspects of the chemistry of the 15th group elements.
16. General aspects of the chemistry of the 16th group elements.
17. General aspects of the chemistry of the 17th group elements.
18. General aspects of the chemistry of the 18th group elements.

4. TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Lectures, seminars and laboratory work face to face.
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of Information and Communication Technologies (ICTs) (e.g. powerpoint) in teaching. The lectures content of the course for each chapter are uploaded on the internet, in the form of a series of ppt files, where from the students can freely download them using a password which is provided to them at the beginning of the course.
TEACHING METHODS *The manner and methods of teaching are described in detail.* *Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.* *The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS*	(see table below)

Activity	***Semester workload***
Lectures (3 contact hours per week x 13 weeks)	39
Seminars (1 contact hour per week x 13 weeks) - solving of representative problems	13
Laboratory experiments (3 contact hours per week x 13 weeks)	39
Final examination (3 contact hours)	3
Hours for private study of the student and preparation of home-works (5 per semester), for Inorganic Chemistry-1, and reports, for the Laboratory, and preparation for the Laboratory (study of techniques and theory)	39
Hours of Private Study of the Student for the preparation of the Final Examination	117
Course total	***250***

STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	1. Oral examination during the seminars on problems given as homework in the lectures. The mark of the seminars is added to the final mark only when the student secures the minimum mark of 5 in the final written examination. 2. Final written examination. Greek grading scale: 1 to 10. Minimum passing grade: 5. ***EXPERIMENTAL INORGANIC CHEMISTRY-1 (EOC-2)*** 1. Written tests of 15 minutes duration at the beginning of each new laboratory period (experiment). The mean mark from these tests consists the 50% of the final grade (G_{EOC-2}). 2. Reports following completion of each laboratory experiment. The mean mark of the consists the other 50% of the final grade (G_{EOC-2}). Minimum passing grade: 5. Final Course Grade (FCG) FCG = (G_{SOC} + G_{EOC-2}) / 2

5. ATTACHED BIBLIOGRAPHY

1. P. Ioannou, "Chemistry of the Elements of the s and p groups", Volume I, Filomatheia Editions, 2006.
2. P. Karagiannidis, "Topics in Inorganic Chemistry: The chemical elements and their compounds", 4th Edition, Ziti Editions, 2009.

Physical Chemistry-1

1. GENERAL

SCHOOL	NATURAL SCIENCES		
ACADEMIC UNIT	CHEMISTRY		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**XA 232**	**SEMESTER**	**2nd**
COURSE TITLE			

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures	3	5
Seminars	1	
Laboratory work	-	
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Field of Science (Basic Physical Chemistry).
PREREQUISITE COURSES:	Typically, there are not prerequisite course, but the students should possess, at least, basic knowledge of Mathematics
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek. Teaching may be however performed in English in case foreign students attend the course.

IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	

2. LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

By the end of this course the student will be able to:

1. Understands the transport phenomena
2. Describes an ideal gas model and by that to deduct and describe its fundamental properties (energy states and state functions).
3. Expands the ideal gas model to the real gases.
4. Understands and apply the first, the second and the third law of thermodynamics.
5. Defines the fundamental energy functions that come from the first law of thermodynamics and from that to be able answers the following questions:
   a) How a system can be defined
   b) Which is the work that a chemical reaction produces
   c) Which are the changes in the state functions of the system that happen in a chemical reaction
6. Defines the fundamental energy functions that come from the second law of thermodynamics and from that to be able answers the following questions:
   a) Which are the changes in the state functions of the system that happen in a chemical reaction
   b) When a chemical reaction is spontaneous
   c) How a heat engine works
7. Construct a graph of energy function and explains them
8. Analyzes the changes of state in physical transformations
9. Describes the systems response of equilibria in physical transformations

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology	*Project planning and management*
Adapting to new situations	*Respect for difference and multiculturalism*
Decision-making	*Respect for the natural environment*
Working independently	*Showing social, professional and ethical responsibility and sensitivity to gender issues*
Team work	*Criticism and self-criticism*
Working in an international environment	*Production of free, creative and inductive thinking*
Working in an interdisciplinary environment	*Others*
Production of new research ideas	

By the end of this course the student will, furthermore, have developed the following skills (general abilities):

1. Ability to exhibit knowledge and understanding of the essential facts, concepts, theories and applications which are related to Chemical Thermodynamics and Changes of State.
2. Uses this knowledge for describing with mathematical models various physical and chemical systems.
3. Uses this knowledge for solving problems related to mass transfer and chemical reactions procedures.
4. Abilities in studding and understanding various concepts in Fields of Science (Natural Sciences, and Medical Sciences) as well as in Industry.

5. Ability to apply this knowledge in experiments which involved in physicochemical systems.

3. SYLLABUS

1. The properties of gases, the compression factor, Virial coefficients, the van der Waals equation, the real gases–the perfect gases, equation of state, the kinetic theory of gases, pV=nRT, mean speed of molecules in a gas, the Maxwell-Boltzmann distribution of speeds, the collision frequency, the mean free path, collisions with walls and surfaces, Graham's law of effusion, Transport properties– theoretical determination of the diffusion coefficient of the Fick's law, thermal conduction and viscosity, Poiseuille's equation.
2. The First Law of Thermodynamics, open–closed–isolated system, work–heat–energy of the system, internal energy of a system, intensive–extensive properties, the first thermal engine of James Watt, reversible changes– p-V diagrams, adiabatic changes, definition of C_p, C_V, step functions–inexact differentials, state functions-exact differentials, gas internal pressure π_T, expansion coefficient α, isothermal compressibility κ_T, The Joule-Thomson effect and the coefficien tμ_T, $C_p-C_V=\alpha(p+\pi_T)V$, isothermal expansion of a perfect gas, adiabatic reversible expansion, heat capacity ratio $\gamma=C_p/C_V$.
3. The Second Law of Thermodynamics, Entropy, the change in entropy for isothermal reversible expansion of a perfect gas, spontaneous and non-spontaneous changes, The Zeroth Law of Thermodynamics, The Third Law of Thermodynamics, thermody- namicengine, heat pumps, Carnot cycle in p-V plot, the Clausius inequality and the definition of the Enthaly, Gibbs and Helmholtz energy, functions, combining the First and Second Laws: the Maxwell relations, derivation of the $\pi_T = T(\partial p/\partial T)_V - p$, derivation of the Gibbs-Helmholtz equations: $[\partial(G/T)/\partial(1/T)]_p=H$ and $[\partial(A/T)/\partial(1/T)]_V=U$, chemical potential of real and perfect gases, fugacity.
4. Thermodynamics supplementary: derivation of the$\Delta S=nR\ln(V_f/V_i)+C_V\ln(T_f/T_i)$, mathematical definition of a reversible change, Carnot cycle in S-T plot, efficient of a heat engine, the third law of thermo-dynamics and the impossibility of reaching absolute zero of tempe-rature, analysis of the Joule-Thomson effect, $\mu=[V(\alpha T-1)/C_p]$, Linde refrigerator and liquefied air.
5. Physical transformations, melting, boiling, sublimation, μ-T plot, the temperature and pressure dependence of chemical potential, Clapeyron equation μ-T and p-T phase diagram, the solid-liquid boundary, the liquid-vapour boundary, the solid-vapour boundary, partial molar quantities, the Gibbs-Duhem equation, the Gibbs energy of two ideal-gases mixing, Francois Rault's and Henry's laws, colligative properties, the elevation of boiling point, the depression of freezing point, Osmosis, liquid-vapour equilibrium, the distillation of mixtures, Azeotropes, J.W.Gibbs'phase rule.

4. TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Lectures and tutorials to amphitheater. Face to face teaching by the active participation of students with questions and exemplary solution of problems related to the theory.
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of Information and Communication Technologies (ICTs) (powerpoint) in teaching.
TEACHING METHODS *The manner and methods of teaching are described in detail.* *Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.* *The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS*	see table below

Activity	*Semester workload*
Lectures (3 contact hours per week x 13 weeks)	39
Tutorials (1 contact hour per week x 13 weeks) - solving of representative problems	13
Final examination (3 contact hours for Physical Chemistry 1)	3
Hours for private study of the student	70
Course total	***125***

STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	1. Two (2) optional written progress during the Semester 2. Final written examination Greek grading scale: 1 to 10. Minimum passing grade: 5.

5. ATTACHED BIBLIOGRAPHY

1. P.W. Atkins, "Physical Chemistry", Volume I, Translation: S. Anastasiadis, G.N. Papatheodorou, S. Farados, G. Fitas, Creta University Press,2005.
2. N.Th. Rakintzis, "Physical Chemistry", 3rdEdition, Papasotiriou Edition, 1994.
3. E. Dallas, "Physical Chemistry", Publications of University of Patras.

Analytical Chemistry-1

1. GENERAL

SCHOOL	NATURAL SCIENCES		
ACADEMIC UNIT	CHEMISTRY		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**XE251**	**SEMESTER**	**2nd**
COURSE TITLE	ANALYTICAL CHEMISTRY 1		

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures	3	10
Seminars	1	
Laboratory work	4	
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Field of Science (Analytical Chemistry).
PREREQUISITE COURSES:	Typically, there are not prerequisite courses. The students should have at least knowledge of the basic concepts of Chemistry.
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek. Teaching may be however performed in English in case foreign students attend the course.
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	http://www.chem.upatras.gr

2. LEARNING OUTCOMES

Learning outcomes *The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful*

completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

By the end of this course the student will be able to:

1. Define basic concepts such as solutions and their characteristics, expressions of the concentration of solutions (molarity, wt. %, etc), precipitates and related terms (precipitation, coagulation, digestion and peptization of colloids, contamination, occlusion and mechanical entrapment, etc) and other concepts of analytical chemistry.
2. Describe and compare the advantages of the various methods of Chemical Analysis.
3. Describe modern analytical techniques that can find applications in a variety of samples (biological, environmental, food, pharmaceuticals, materials and artwork).
4. Perform equilibrium calculations for weak acid and weak base solutions.
5. Choose appropriate pH-indicators and carry out relevant calculations of pH.
6. Perform calculations for the preparation of buffer solutions.
7. Describe the importance of solubility product for the selective precipitation of compounds and the separation of ions.
8. Derive equations and perform calculations in equilibria involving sparingly soluble salts and fractional precipitation.
9. Derive equations and perform calculations in equilibria involving complex formation.
10. Derive equations to describe equilibria in oxidation-reduction systems. Galvanic cells. Electrochemical potentials. Applications of potentials in chemical analysis.
11. Extraction.
12. Chromatography.
13. Describe the methodology for a correct chemical analysis (bestpractice).
14. Describe fundamental laboratory techniques as well as their advantages and their limitations, e.g. solid–liquid separations methods.
15. Choose the pathways for the separation and identification of chemical substances, combining analytical methodsto resolve complex problems.
16. Be able to combine and apply the knowledge acquired in other fields of Chemistry (e.g. Organic Chemistry, Biochemistry etc) in which certain notions and principles of the course in question are necessary and useful and vice-versa.
17. Describe all the safety rules to be applied in a chemical laboratory and recognize what one must not do.

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology	*Project planning and management*
Adapting to new situations	*Respect for difference and multiculturalism*
Decision-making	*Respect for the natural environment*
Working independently	*Showing social, professional and ethical responsibility and sensitivity to gender issues*
Team work	*Criticism and self-criticism*
Working in an international environment	*Production of free, creative and inductive thinking*
Working in an interdisciplinary environment	*Others*
Production of new research ideas	

By the end of this course the student will have developed the following skills/competences:

1. Find his/her way in a book of General and Analytical Chemistry to be used as a source of information (e.g. equilibrium constants).
2. Solve problems related to chemical analysis.
3. Use and convert easily the measurement units of various physical quantities and constants

4. Choose the appropriate analytical method for the separation, identification and quantitative analysis of specific substances. 5. Identify and name glassware and apparatus in a chemical laboratory. 6. Organize his/her work in the lab, select the appropriate glassware, perform calculations and prepare standard solutions, etc. 7. Be familiar with the laboratory apparatus and common techniques and their uses, e.g. filtration, centrifugation, extraction, etc. 8. Keep a laboratory notebook. 9. Be able to cooperate in a chemical lab (work in a group). 10. Work following all the standard safety rules for a chemical lab. 11. Be able to adapt to the continuously evolving Analytical Laboratory.

3. SYLLABUS

1. Importance of Analytical Chemistry for Science and everyday life. 2. Methods of chemical analysis. 3. Solutions (water as a solvent, expressions of concentration and conversion between units, principle of mass/matter conservation, principle of electrical neutrality, etc.) 4. Chemical equilibrium of weak acids and bases. 5. Hydrolysis. 6. Formation and dissolution of precipitates. Fractional and homogeneous precipitation. 7. Equilibrium in solutions of complexes. 8. Chemical equilibrium of a redox system. 9. Extraction. 10. Chromatography. 11. Exercises and solutions to problems in the above chapters. 12. Basic chemical laboratory techniques and apparatus (sampling,weighting, volume measurement, precipitation, centrifugation, filtration etc). Theory and practice in an analytical lab. *Laboratory exercises:* 1. Separation and identification of cations and anions in solutions (groups I–IV). 2. Qualitative analysis of an unknown solid substance. 3. Chromatography: paper, thin layer, ion exchange.

4. TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	1. Lectures using power-point presentations. The students are asked to find information in their documents. Educational software and use of the Internet facilities for information retrieval from data bases and other sources. 2. Tutorials focused on problem solving and exercises of various types: multiple choice, right/wrong, filling the gaps, balancing chemical equations. 3. Laboratory exercises: analysis of solutions of ions or organic substances. Analysis of solid samples.
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of Information and Communication Technologies (ICTs) (powerpoint) in Lectures.
TEACHING METHODS *The manner and methods of teaching are described in detail.* *Lectures, seminars, laboratory practice, fieldwork, study*	

Activity	*Semester workload*
Lectures (3 contact hours per week x 13 weeks)	39

and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc. *The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS*	Seminars (1 contact hour per week x 13 weeks) - solving of representative problems	13
	Laboratory exercises (4 contact hours per week x 12 weeks)	48
	Final written examination (3 contact hours)	3
	Final written examination of the lab (1 contact hour)	1
	Private study time of the student and preparation for the half-term evaluations and final examination	146
	Course total	***250***
STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	1. Evaluation of the result of analysis of unknown solutions. 2. Written tests during the laboratory practice through the whole semester. Questions on the theory and problem solving of the same type with those practiced in the tutorials. In order to consider that the student has succeeded in the laboratory practice, the mean value of the marks obtained for the results of the analysis of the unknown solutions and the corresponding test must be at least 5 (pass in 0-10 scale). This consists the 50 % of the final mark. 3. Writtenexamination at the end of the semester. The mark obtained will be the 60% of the final mark provided that it is higher than 5. Greek grading scale: 1 to 10. Minimum passing grade: 5.	

5. ATTACHED BIBLIOGRAPHY

1. T.P. Hadjiioannou, "Chemical equilibrium and inorganic qualitative semimicroanalysis", D. Mavrommati Edition, 1999.
2. W.R. Robinson, J.D. Odom, H.F. Holtzclaw Jr., "General Chemistry, with Qualitative Analysis", 10th Edition, Houghton Mifflin Company, 1997.
3. Group authorship of the lab, "Laboratory exercices in Analytical Chemistry, Publications of University of Patras, 2015-2016.

Organic Chemistry of Functional Groups-I

1. GENERAL

SCHOOL	NATURAL SCIENCES		
ACADEMIC UNIT	CHEMISTRY		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**XO202**	**SEMESTER**	**2nd**
COURSE TITLE	ORGANIC CHEMISTRY OF FUCTIONAL GROUPS I		

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures	3	5
Seminars	1	
Laboratory work	-	
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Field of Science (Organic Chemistry).
PREREQUISITE COURSES:	Typically, there are not prerequisite courses. Essentially, the students should possess the knowledge provided through the previously taught theoretical course "Structure, Reactivity and Mechanisms in Organic Chemistry'' (1st semester).
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek. Teaching may be however performed in English in case foreign students attend the course.
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	

2. LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

By the end of this course the student will be able to:

Be familiar with the general chemistry of the following classes of organic compounds: alkanes, alkenes, alkynes, alkyl halides (halo alkanes), alcohols, phenols, ethers. epoxides, benzene and its derivatives.

Specifically:

Alkanes

Account for "strain" in small rings. Relate the difficulty of forming cyclic systems to the size of ring required.

Alkenes

Use simple orbital overlap theory to account for non-rotation about *pi* bonds, conjugation, the stability of allyl carbocations, and the features of the Diels-Alder reaction. Utilise the chemo- and stereo-selective nature of the Lindlar catalyst.

Aromatic compounds

Explain the structure, stability and reactivity of benzene using the concept of resonance. Identify simple non-benzenoid aromatic molecules by using Hückel's rule. Distinguish between Friedel-Crafts alkylation and acylation reactions for use in synthesis. Explain the stability of the benzyl free radical, cation and anion, and show how this determines the chemistry of toluene and its side-chain derivatives.

Explain how reaction conditions determine the position of substitution in naphthalene.

Alkyl halides (haloalkanes and haloaromatic compounds)

Exploit the usefulness of alkyl halides in synthesis, especially through substitution and organometallic reagents. Account for the reduced reactivity of "non activated" halo aromatics and halo alkenes.

Alcohols and phenols, ethers and epoxides

Exploit the usefulness of alcohols and epoxides in synthesis. Account for the acidity of phenols. Explain the behaviour of crown ethers.

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology

Adapting to new situations

Decision-making

Project planning and management

Respect for difference and multiculturalism

Respect for the natural environment

Showing social, professional and ethical responsibility and sensitivity to

Working independently	*gender issues*
Team work	*Criticism and self-criticism*
Working in an international environment	*Production of free, creative and inductive thinking*
Working in an interdisciplinary environment	*Others*
Production of new research ideas	

By the end of this course the student will, furthermore, have developed the following skills (general abilities):

1. Ability to exhibit knowledge and understanding of the essential facts, concepts, theories and applications which are related to Organic Chemistry.
2. Ability to apply this knowledge and understanding to the solution of problems related to Organic Chemistry of non-familiar nature.
3. Ability to adopt and apply methodology to the solution of non-familiar problems of Organic Chemistry.
4. Study skills needed for continuing professional development.
5. Ability to interact with others in chemical or of interdisciplinary nature problems.

Generally, by the end of this course the student will, furthermore, have develop the following general abilities (from the list above):

Searching, analysis and synthesis of facts and information, as well as using the necessary technologies
Adaptation to new situations
Decision making
Autonomous (Independent) work
Group work
Exercise of criticism and self-criticism
Promotion of free, creative and inductive thinking
Respect to natural environment
Work design and management

3. SYLLABUS

Alkanes

Sources, preparation, oxidation, free radical halogenation, combustion. Cycloalkanes - small, medium and large rings, ring strain.

Alkenes

Electronic structure, *cis-trans* isomers, preparation via elimination reactions. Addition reactions - hydrogenation, electrophilic addition of HX, H2O, halogens, orientation of alkene addition reactions, Markovnikov's rule, carbocation structure and stability, addition in the presence of peroxides - anti-Markovnikov. Hydroboration. Oxidation of alkenes by manganate(VII), peroxo-acids, and ozone. Conjugated dienes, resonance, stability of allylic carbocations, 1,2- and 1,4- addition to dienes. Cycloaddition reactions (Diels-Alder).

Alkynes

Structure and preparation. Electrophilic addition of H_2, water, HX and X_2, acidity, formation of alkyne anions, coupling reactions.

Aromatic Compounds

Structure and stability of benzene, resonance, Hückel's rule, simple non-benzenoid aromatics (cyclopentadienyl, tropylium). Electrophilic aromatic substitution - halogenation, nitration, sulfonation, the Friedel- Crafts alkylation and acylation reactions. Isomerism of benzene derivatives, reactivity and orientation of reactions on substituted aromatic rings, oxidation and reduction of aromatic compounds. Side-chain halogenation, benzyl as a free radical, cation and anion. Naphthalene. Kinetic *vs* thermodynamic control.

Alkyl halides (haloalkanes and haloaromatic compounds)

Preparation from alcohols, nucleophilic substitution reactions, elimination reactions, Grignard reagents. Haloaromatics and haloalkenes, their resistance to nucleophilic attack. Allylic bromination.

Alcohols and phenols, ethers and epoxides

Primary, secondary and tertiary alcohols. Acidity of alcohols and phenols, hydrogen bonding. Synthesis of alcohols from alkenes and from carbonyl compounds. Reactions of alcohols - with hydrogen halides, phosphorus halides, dehydration, reaction with metals, acylation, oxidation. Synthesis and reactions of phenols - oxidation, acylation. Williamson ether synthesis, acidic cleavage, cyclic ethers and crown ethers.

Synthesis and ring-opening reactions of epoxides.

4. TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face to face.
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of powerpoint presentation in teaching.
TEACHING METHODS *The manner and methods of teaching are described in detail.* *Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.* *The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS*	see table below
STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	1. Optionally, two (2) progress examinations, one at the middle and one the end of semester (mid-term). Minimum passing grade for each: 5. 2. Written examination after the end of the semester. Minimum passing grade: 5.

Activity	***Semester workload***
Lectures (3 contact hours per week x 13 weeks) Tutorials (1 contact hour per week x 13 weeks – Analysis of problem solving strategy and solution of representative problems)	52
Two (2) progress examinations, one at the middle (mid-term) and one the end of semester (2 contact hours for each exam)	4
Final examination (3 contact hours)	3
Hours for private study of the student	66
Course total	***125***

5. ATTACHED BIBLIOGRAPHY

1. L. G. Wade JR, "Organic Chemistry", Translation to Greek: D. Komiotis et al, A. Tziolas and Sons Publications, 2010.
2. J. McMurry, "OrganicChemistry", Translation to Greek: A. Varvoglis, M. Orfanopoulos, I. Smonou et al, University of Crete Publications, 2012.
3. Devid Klein, "OrganicChemistry", Translation to Greek: G. Kokotoset al, Utopia Publications, 2015.
4. T. Mavromoustakos, T Tselios, K. Papakonstantinou, "Basic Proncitples of Organic Chemistry", in Greek language, Symemtria Publications, 2014.

3rd Semester (III) (first applied in 2017-18)

Analytical Chemistry-2

1. GENERAL

SCHOOL	NATURAL SCIENCES
ACADEMIC UNIT	CHEMISTRY
LEVEL OF STUDIES	UNDERGRADUATE

COURSE CODE	**XE352**	**SEMESTER**	**3rd**
COURSE TITLE	ANALYTICAL CHEMISTRY-2		

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures	2	5
Seminars	-	
Laboratory work	5	
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Field of Science (Analytical Chemistry).
PREREQUISITE COURSES:	The students should have a basic knowledge of General Chemistry.
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek. The course can be, however, taught in English in case foreign students attend the course.
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	

2. LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

By the end of this course the student should:

1. Acknowledge the capabilities of the various quantitative analytical chemistry techniques and have the ability to compare them.
2. Have an understanding of modern analytical techniques applied widely in a variety of samples (e.g. biological samples, environmental samples, foodstuff, drugs, materials, artworks).
3. Present flexibility in combining analytical techniques to solve complex problems.
4. Have the ability to combine and exploit the knowledge gained also in other fields of Chemistry in which concepts of the current course are extensively used (e.g. Organic Chemistry, Biochemistry, etc.).

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology	*Project planning and management*
Adapting to new situations	*Respect for difference and multiculturalism*
Decision-making	*Respect for the natural environment*
Working independently	*Showing social, professional and ethical responsibility and sensitivity to gender issues*
Team work	*Criticism and self-criticism*
Working in an international environment	*Production of free, creative and inductive thinking*
Working in an interdisciplinary environment	*Others*
Production of new research ideas	

By the end of this course the student will have further developed the following skills (general abilities):

1. Ability to exhibit knowledge and understanding of the essential facts, concepts, theories and applications related to Analytical Chemistry.
2. Ability to apply this knowledge and understanding to the solution of Analytical Chemistry problems of non-familiar nature.
3. Ability to adopt and apply methodology to the solution of non-familiar problems.
4. Study skills needed for continuing professional development.
5. Ability to interact with others in chemical or of interdisciplinary nature problems.
6. To work in a chemical lab following the safety rules.

Generally, by the end of this course the student will, furthermore, have developed the following general abilities (from the list above):
Searching, analysis and synthesis of facts and information, as well as using the necessary technologies
Adaptation to new situations
Decision making
Autonomous (Independent) work
Exercise of criticism and self-criticism
Promotion of free, creative and inductive thinking

3. SYLLABUS

- Classification of quantitative chemical analysis methods.
- Sampling, sample treatment, measurement techniques, instruments and chemical reagents.
- Statistical treatment of analytical data (accuracy, precision etc), errors in chemical analysis, significant figures, methods for reporting analytical data.
- Classification of gravimetric methods. Precipitation (homogeneous precipitation, crystal growth, colloids, impurities, digestion, errors in gravimetric analysis).
- Classification of titrimetric methods, standard solutions, indicators.
- Acid/base equilibria and titrations, complexometric titrations, precipitation titrations, reduction/oxidation titrations, acid-base titrations in non-aqueous solvents, errors in titrimetric analysis.
- Buffer solutions, titration curves for strong/weak acids and bases, mass balance and charge balance equations, errors.
- Evaluation and comparison of gravimetric and titrimetric analytical methods.
- Solving problems in the above chapters.

Laboratory exercises

- Introduction to the Laboratory of Analytical Chemistry-2 (instruments, chemical reagents, preparation of solutions, safety rules etc.)
- Determination of sodium carbonate (neutralization titration)
- Determination of calcium and total hardness of water with EDTA (complexometric titration).
- Determination of iron^{II} with potassium permanganate (redox titration)
- Determination of copper^{II} with iodide (iodometry)
- Determination of ascorbic acid with iodine (iodimetry)
- Determination of nicotine in tobacco (non-aqueous acid-base titration)
- Determination of nickel with dimethylglyoximate (gravimetric analysis)

4. TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Lectures and laboratory work face to face.
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of Information and Communication Technologies (ICTs) (e.g. powerpoint) in teaching. Use of the Internet for the exploitation of scientific sites and the extraction of information from databases on Analytical Chemistry issues.

	Communication with the students is established either through email or through the webpage of the Chemistry Department.
TEACHING METHODS *The manner and methods of teaching are described in detail.* *Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.* *The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS*	see table below

Activity	*Semester workload*
Lectures (2 contact hours per week x 13 weeks)	26
Half-term evaluations (2, the first in the middle and the second one at the end of the semester, 1 contact hour each)	2
Laboratory work (5 contact hour per week x 12 weeks)	60
Final written examination (2 contact hours)	2
Hours for private study of the student and preparation for the half-term evaluations and/or the final examination.	35
Course total	***125***

STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	1. Optionally, half-term written examinations: one at the middle and the other one at the end of the semester. The final grade is the average of the two half-term examinations. The student should secure at least the grade 6 (0-10 scale) in the first half-term in order to participate in the second one. This score represents the 60% of the final grade of the course. 2. Written examination after the end of the semester (unless the student successfully participated in the half-term exams). Minimum passing grade: 5. This score represents the 60% of the final grade of the course. 3. Grade of laboratory work: This score is the 40% of the final grade of the course (minimum passing grade: 5). All of the above are taking place in the Greek language and for the foreign students (e.g. ERASMUS students) in English.

5. ATTACHED BIBLIOGRAPHY

1. D.C. Harris, "Quantitative Chemical Analysis", W.H. Freeman & Company, 2007.
2. G.D.Christian, P.K. Dasgupta, K.A. Schug, "Analytical Chemistry", J. Wiley & Sons, 2013.
3. D.A. Skoog, D.M. West, F.J. Holler, "Analytical Chemistry, An Introduction", Saunders College Publishing, 1992.
4. "Vogel's Textbook of Quantitative Chemical Analysis", Revised by G.H. Jeffery, J. Bassett, J. Mendham, R.C. Denney, Longman Scientific & Technical, 1989.
5. T.P. Hadjiioannou, A.K. Kalokerinos, M. Timotheou-Potamia, "Quantitative Analysis", Athens, 2017.
6. V. Nastopoulos, C. Papadopoulou, "Quantitative Analysis Laboratory Notes", University of Patras Publication Centre, 2017.

Inorganic Chemistry-2 (Chemistry of 1st Row Transition Metals and of Coordination Compounds)

1. GENERAL

SCHOOL	NATURAL SCIENCES		
ACADEMIC UNIT	CHEMISTRY		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**XA323**	**SEMESTER**	**3rd**

COURSE TITLE	INORGANIC CHEMISTRY-2 (CHEMISTRY OF TRANSITION METALS)	
INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures	3	10
Seminars	1	
Laboratory work	3	
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Field of Science (Inorganic Chemistry of Transition Metals-Coordination Chemistry) and Skills Development (Synthetic Inorganic Chemistry).
PREREQUISITE COURSES:	Typically, there are no prerequisite courses. It is recommended that the students should have passed the previous courses “Introduction to Inorganic Chemistry” and “Inorganic Chemistry 1”.
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek. Teaching may be however performed in English in case foreign students attend the course.
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	https://eclass.upatras.gr/courses/CHEM2062/ https://eclass.upatras.gr/courses/CHEM2061/

2. LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

At the end of this course the student should be able to:

1. Recognize d-block elements and write their ground-state electronic configurations.
2. Discuss the oxidation states of d-block elements.
3. Explain the variation of radii, ionization energies and other physical properties of d-block elements both horizontally and vertically within the Periodic Table.
4. Describe occurrence, metallurgy, chemical properties and uses of representative first row d-block metals.
5. Know the basic features of coordination chemistry (definition of the coordination complex, terminology, ligands, coordination numbers, stereochemistry, colours, magnetic properties, stability, isomerism, and applications of the metal complexes).
6. Discuss and analyze the bonding in coordination complexes (valence-bond theory, crystal field theory, molecular orbital theory).
7. Prepare, purify, crystallize and characterize coordination complexes of first-row d-block metal ions.

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology

Adapting to new situations

Project planning and management

Respect for difference and multiculturalism

Respect for the natural environment

Decision-making *Working independently* *Team work* *Working in an international environment* *Working in an interdisciplinary environment* *Production of new research ideas*	*Showing social, professional and ethical responsibility and sensitivity to gender issues* *Criticism and self-criticism* *Production of free, creative and inductive thinking* *Others*

At the end of the course the student will have further developed the following skills/competences:

1. Ability to demonstrate knowledge and understanding of concepts and principles related to the chemistry of the d-block elements.
2. Ability to demonstrate knowledge and understanding of concepts and principles related to coordination chemistry.
3. Ability to apply such knowledge and in-depth understanding to solve exercises of unfamiliar nature.
4. Ability to interact with others on interdisciplinary problems.
5. Skills enabling the student to synthesize and study coordination complexes.

3. SYLLABUS

1. The first-row d-block metals

a) Definitions.
b) Occurrence, metallurgy and uses.
c) Electronic configurations of atoms and ions.
d) Physical properties.
e) The reactivity of the metals.
f) Characteristic properties (colour of their compounds, paramagnetism, complex formation).

2. Descriptive chemistry of titanium, iron and copper

For each metal:

a) Occurrence, extraction and uses.
b) Physical properties.
c) Reactions.

3. Basic coordination chemistry

a) Historical background.
b) The coordination complex: Definitions and the Werner era.
c) Ligands (monodentate, bidentate, polydentate, terminal, bridging).
d) Coordination numbers and geometries.
e) Nomenclature
f) Isomerism in d-block metal complexes (ionization isomers, hydration isomers, coordination isomers, linkage isomers, polymerization isomers, geometrical isomers, optical isomers).
g) Applications of coordination complexes in technology, biology and medicine.
h) Stability constants of coordination complexes.

4. Bonding in d-block metal complexes

a) Valence Bond Theory (hybridization schemes, applying VBT).
b) Crystal Field Theory (the octahedral crystal field, crystal field stabilization energy, high- and low-spin octahedral complexes, the tetrahedral crystal field, the square planar crystal field, spectrochemical series of ligands, colours of metal complexes).
c) Molecular Orbital Theory (octahedral complexes, complexes with no metal-ligand π bonding, complexes with metal-ligand π bonding).

5. Laboratory exercises

a) Synthesis, purification and crystallization of d-block metal compounds and complexes, such as the double nickel(II)/ammonium/sulfate salt, potassium dichromate, potassium/chromium(III) alum, hexaamminonickel(II) chloride and bromide, bis(dimethylglyoximato) nickel(II), catena-tetra(μ-

thiocyanato) cobalt(II) mercury(II), catena-tetrakis(aspirinato)dicopper(II), copper(I)chloride, bis(aquo)tetrakis (acetato) dichromium(II), octahedral cobalt(III) ammino complexes, etc. b) Characterization of the above-mentioned compounds by means of conductivity measurements, room-temperature magnetochemistry, IR and UV/VIS/ligand field spectroscopies.

4. TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Lectures, seminars and laboratory work face to face.
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of Information and Communication Technologies (ICTs) (e.g. powerpoint) in teaching. Use of ICTs in the seminars providing information on the theory and practice of the laboratory experiments and the methodology for multi-step syntheses.
TEACHING METHODS *The manner and methods of teaching are described in detail.* *Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.* *The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS*	see table below

Activity	*Semester workload*
Lectures (3 contact hours per week x 13 weeks)	39
Seminars (1 contact hour per week x 13 weeks)-solving of representative problems	13
Laboratory work (3 contact hours per week x 13 weeks)	39
Final examination (3 contact hours for the Theory and 3 contact hours for the Laboratory Exercises)	6
Hours for private study of the student and preparation of home-works	153
Course total	***250***

STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	1) Written examination of the Theory after the end of the semester. The mark consists 50% of the final grade. Minimum passing grade:5. 2) Written examination in the concepts of the Laboratory exercises. The mark consists the other 50% of the final grade. Minimum passing grade: 5.

5. ATTACHED BIBLIOGRAPHY

1. D. Kessissoglou, P. Akrivos, "Biocoordination Chemistry", Vol. I: Theory, Ziti Publishing Company, 2006.
2. D. Kessisoglou, P. Akrivos, P. Aslanidis, P. Karafiloglou, A. Dendrinou-Samara, "Biocoordination Chemistry", Vol. II: Synthesis and Study of Coordination Compounds, Ziti Publishing Company, 2006.

Physical Chemistry-2

1. GENERAL

SCHOOL	NATURAL SCIENCES		
ACADEMIC UNIT	CHEMISTRY		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**XA333**	**SEMESTER**	**3rd**

COURSE TITLE	PHYSICAL CHEMISTRY-2	
INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures	3	5
Seminars	1	
Laboratory work	-	
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Field of Science (Physical Chemistry).	
PREREQUISITE COURSES:	There are no prerequisite courses.	
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek. However, the course can be taught in English if foreign students are enrolled.	
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES	
COURSE WEBSITE (URL)		

2. LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

At the end of the course the student will be able to have basic knowledge for the interpretation of spectroscopic observations and measurements.

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology
Adapting to new situations
Decision-making
Working independently
Team work
Working in an international environment
Working in an interdisciplinary environment
Production of new research ideas
Project planning and management
Respect for difference and multiculturalism
Respect for the natural environment
Showing social, professional and ethical responsibility and sensitivity to gender issues
Criticism and self-criticism
Production of free, creative and inductive thinking
Others

At the end of this course the student will further develop the following skills:

Using advanced specialized software in applications in Chemistry: Spectroscopy, Molecular Modelling in Organic and Inorganic Chemistry.

3. SYLLABUS

- Historical introduction. The discovery of th electron by J.J. Thomson. Black body radiation and classical physics. Planck's Law. The electronic spectrum of the hydrogen atom. Rydberg's equation. Quantization of the angular momentum and Bohr's model of the hydrogen atom. De Broglie's theory, wave properties of matter. Heisenberg's Uncertainty Principle.

- The wave equation. The vibrating spring. Solving the wave equation by variable separation. General solution of the wave equation.
- Schrödinger's equation and some simple problems. Solving Schrödinger's equation: an eigenvalue problem. Observables and linear operators in Quantum Mechanics. A particle in a potential well: energy quantization. Uncertainty principle for a particle in a potential well.
- General principles of quantum Mechanics. The state of a system. Linear operators in Quantum Mechanics. Time-dependence of the wavefunction. Quantum mechanical operators, commutation and the uncertainty principle.
- The harmonic oscillator. Schrödinger's equation and energy levels. Infrared spectra of diatomic molecules. Asymptotic solution of Schrödinger's equation.
- Three-dimensional problems. Particle-in-a-box. Separable hamilto-nian operators and the corresponding wavefuctions. Schrödinger's equation for the hydrogen atom. Symmetry of s orbitals. Schrödinger's equation for the helim atom.
- Approximative methods. Perturbation theory. The variational principle.
- Atoms. Atomic units system. Studying the helium atom. Hartree-Fock equations and the self-consistent field method. Antisymmetric wavefunctions. Hartree-Fock calculations and comparison with experimental data.

4. TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Lectures and seminars face-to-face.
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of Information and Communication Technologies (ICTs) (powerpoint) in Lectures. Seminars. Problems are solved in an exemplary way. The course includes practical exercises through the application of specialized software for the study of basic characteristics of atoms and molecules.
TEACHING METHODS *The manner and methods of teaching are described in detail.* *Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.* *The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS*	see table below
STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	One written examination at end of Semester 100% of grade. Minimum passing grade: 5.

Activity	***Semester workload***
Lectures (3 contact hours per week x 13 weeks)	39
Seminars (1 contact hour per week x 13 weeks) - solving of representative problems	13
Final written examination (3 contact hours)	3
Private study time of the student and preparation for final examination	70
Course total	***125***

5. ATTACHED BIBLIOGRAPHY

1. D. A. McQuarrie, "*Quantum Chemistry*", University Science Books, 1983.
2. C. J. Cramer, "*Computational Chemistry: theories and models*", Wiley, 2004.

Instrumental Chemical Analysis-1

1. GENERAL

SCHOOL	NATURAL SCIENCES		
ACADEMIC UNIT	CHEMISTRY		
LEVEL OF STUDIES	UNDERGRADUATE (BACHELOR of SCIENCE)		
COURSE CODE	**XE 353**	SEMESTER	**3rd**
COURSE TITLE	INSTRUMENTAL CHEMICAL ANALYSIS-1		
INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	**WEEKLY TEACHING HOURS**	**CREDITS**	
Lectures	3	5	
Seminars	1		
Laboratory work	-		
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).			
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Field of Science (Analytical Chemistry)		
PREREQUISITE COURSES:	There are no prerequisite courses. It is however recommended that students have basic knowledge of Qualitative analysis and Quantitative analysis.		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek. However, the course can be taught in English if foreign students are enrolled.		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES		
COURSE WEBSITE (URL)	http://www.chem.upatras.gr, http://eclass.upatras.gr		

2. LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

At the end of this course the student will know:

Chromatographic Techniques in Chemical Analysis

1. The basic chromatographic parameters: Distribution constant, Retention time, Retention factor and their physical meaning. Ability to use these parameters to calculate from a chromatogram other basic parameters such as the Selectivity Factor and the Resolution.
2. The Plate theory and its basic assumptions. Calculation of the Number of Theoretical Plates from a chromatogram. The Rate Theory and van Deemter equation, with its graphical representations for Gas and Liquid Chromatography- HPLC.
3. Recognize the classes of analytes to be determined by Gas Solid and Gas Liquid Chromatography (with packed and capillary columns). Ability to select the appropriate column and detector for the separation

and determination of various analytes by Gas Chromatography.

4. Recognize the various types of Liquid Chromatography-HPLC (Liquid-Solid Chromatography, Liquid-Liquid Chromatography Normal and Reverse Chromatography, Ion Chromatography and Size Exclusion Chromatography). Select the appropriate column for a certain separation and the appropriate detector for the determination of various analytes. Understand the role of the solvent in HPLC.
5. Perform Qualitative and Quantitative Analysis by chromatography employing various calibration techniques.

Electroanalytical Techniques

1. *Potentiometry.* Indicator electrodes. Development of electrical potentials. Development of membrane potentials. Reference electrodes. The liquid junction potential. Electrodes selective to molecules. Principle and architecture of potentiometric gas sensors. Principle and architecture of biocatalytic membrane electrodes. Quantitative analysis by potentiometry. Direct potentiometric methods. Calibration methods. Errors in potentiometry. Potentiometric titrations.
2. *Coulometry.* Principle of coulometric titrations. Advantages of coulometric titrations. Various types of coulometric titrations: Acid-base titrations; precipitation titrations; complex-formation titrations; oxidation reduction titrations. Electrochemical cells for coulometry. Problems.
3. *Voltammetry.* Principles of voltammetric sensors. Applications.

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology	*Project planning and management*
Adapting to new situations	*Respect for difference and multiculturalism*
Decision-making	*Respect for the natural environment*
Working independently	*Showing social, professional and ethical responsibility and sensitivity to gender issues*
Team work	*Criticism and self-criticism*
Working in an international environment	*Production of free, creative and inductive thinking*
Working in an interdisciplinary environment	*Others*
Production of new research ideas	

At the end of the course the student will have further developed the following skills/competences:

1. Ability to demonstrate knowledge and understanding of essential facts, concepts, principles and theories relating to Chromatography
2. Ability to apply such knowledge and understanding to the solution of qualitative and quantitative problems of an unfamiliar nature.
3. Ability to adopt and apply methodology to the solution of unfamiliar problems.
4. Study skills needed for continuing professional development.
5. Ability to interact with others on inter or multidisciplinary problems.
6. Propose membrane composition for potentiometric determination of various ions or molecules.
7. Predict interferences in potentiometric determinations.
8. Selection of a reference electrode.
9. Ability to develop potentiometric determinations including calibration and calculations.
10. Development of coulometric titrations.

3. SYLLABUS

1. *General Concepts of Chromatography*: Distribution Constants, Retention time, Retention Factor, Selectivity Factor, Plate Theory, Rate Theory, Van Deemter equation for Gas and Liquid Chromatography. Resolution and factors that affect the resolution.
2. *Gas Chromatography*: Instrumentation for Gas Chromatography. Carrier Gas. Solid support. Liquid Stationary Phase. Temperature programming. Capillary columns in Gas Chromatography. Adsorbents. Detectors FID, TCD and ECD.
3. *Liquid Chromatography*: Types of Liquid Chromatography. Instrumentation. Liquid-SolidChromatography. Adsorbents. Liquid-Liquid Chromatography. Stationary phases of Liquid-Liquid Chromatography for

Normal and Reverse Phases. TheroleofMobilePhase. Gradient Elution. Detectors: UV/Visible, Diode Array and Refractive Index Detector. Ion Chromatography with chemical suppression. Size Exclusion Chromatography. Gel Permeation and Gel Filtration Chromatography.

4. *Qualitative and Quantitative Analysis*: Kovats Index. Quantitative analysis various calibration techniques.
5. *Electroanalytical Techniques*
6. *Potentiometry*. Indicator electrodes. Development of electrical potentials. Development of membrane potentials. Reference electrodes. The liquid junction potential. Electrodes selective to molecules. Principle and architecture of potentiometric gas sensors. Principle and architecture of biocatalytic membrane electrodes. Quantitative analysis by potentiometry. Direct potentiometric methods. Calibration methods. Errors in potentiometry. Potentiometric titrations.
7. *Coulometry*. Principle of coulometric titrations. Advantages of coulometric titrations. Various types of coulometric titrations: Acid-base titrations; precipitation titrations; complex-formation titrations; oxidation reduction titrations. Electrochemical cells for coulometry. Problems.
8. *Voltammetry*. Principles of voltammetric sensors. Applications.

4. TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Lectures
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of Information and Communication Technologies (ICTs) (powerpoint) in Lectures. Course lectures and exemplary solved problems for every chapter. Seminars. Problems are solved in an exemplary way summarizing before the theory behind each problem.
TEACHING METHODS *The manner and methods of teaching are described in detail.* *Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.* *The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS*	see table below

Activity	***Semester workload***
Lectures (3 contact hours per week x 13 weeks)	39
Seminars (1 contact hour per week x 13 weeks) - solving of representative problems	13
Final written examination (3 contact hours)	3
Private study time of the student and preparation for the final examination	70
Course total	***125***

STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	One written examination at end of Semester 100% of grade. Minimum passing grade: 5.

5. ATTACHED BIBLIOGRAPHY

1. D.A. Skoog, F.J. Holler, T.A. Nieman, "Principles of Instrumental Analysis ", 6th Edition, Thomson Brooks Cole Publications, 2007.
2. Th. Hatjiioannou and M.A. Kouppari, "Instrumental Analysis, Mavrommatis Publications, 2003.
3. D. C. Harris, "Quantitative Chemical Analysis", 8th Ed., W. H. Freeman and Company Publications, 2010.

Organic Chemistry of Functional Groups-II

1. GENERAL

SCHOOL	NATURAL SCIENCES		
ACADEMIC UNIT	CHEMISTRY		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**XO 303**	**SEMESTER**	**3rd**
COURSE TITLE	ORGANIC CHEMISTRY OF FUCTIONAL GROUPS-II		

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures	3	5
Seminars	1	
Laboratory work	-	
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Field of Science (Organic Chemistry)
PREREQUISITE COURSES:	Typically, there are not prerequisite course. Essentially, the students should possess the knowledge provided through the previously taught theoretical courses: "Structure, Reactivity and Mechanisms in Organic Chemistry'' (1st semester) and "Organic Chemistry of Functional Groups I" (2nd semester).
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek. Teaching may be however performed in English in case foreign students attend the course.
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	https://eclass.upatras.gr/courses/

2. LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

By the end of this course the student will be able to:

Be familiar with the general chemistry of the following classes of organic compounds: Aldehydes, ketones, Carboxylic acids and their derivatives, Amines and other nitrogen containing compounds (e.g. nitro).

Specifically:

Aldehydes –ketones, Carboxylic acids and derivatives:

1. Present the most important reactions-methods for the preparation of carbonyl compounds and reactions involving inter-conversion of carbonyl groups. Present the most important reactions with the participation of carbonyl group.
2. Evaluate chemical methods and propose-apply methods for the synthesis and inter-conversion of

carbonyl compounds andtheirconversiontootherorganiccompounds.

3. Present the applications and use of carbonyl compounds.

Amines and other nitrogen containing compounds

Distinguish between the behaviour of amines as nucleophiles and bases, and between nitrogen in sp3, sp2 and sp hybridization. Explain the basicity of amines, and the reduced basicity of amides. Understand the usefulness of diazonium compounds and apply them in the synthesis of substituted aromatic derivatives.

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology
Adapting to new situations
Decision-making
Working independently
Team work
Working in an international environment
Working in an interdisciplinary environment
Production of new research ideas
Project planning and management
Respect for difference and multiculturalism
Respect for the natural environment
Showing social, professional and ethical responsibility and sensitivity to gender issues
Criticism and self-criticism
Production of free, creative and inductive thinking
Others

By the end of this course the student will, furthermore, have developed the following skills (general abilities):

1. Ability to exhibit knowledge and understanding of the essential facts, concepts, theories and applications which are related to Organic Chemistry.
2. Ability to apply this knowledge and understanding to the solution of problems related to Organic Chemistry of non-familiar nature.
3. Ability to adopt and apply methodology to the solution of non-familiar problems of Organic Chemistry.
4. Study skills needed for continuing professional development.
5. Ability to interact with others in chemical or of interdisciplinary nature problems.

Generally, by the end of this course the student will, furthermore, have develop the following general abilities:
Searching, analysis and synthesis of facts and information, as well as using the necessary technologies
Adaptation to new situations
Decision making
Autonomous (Independent) work
Group work
Exercise of criticism and self-criticism
Promotion of free, creative and inductive thinking
Respect to natural environment
Work design and management

3. SYLLABUS

Aldehydes –ketones, Carboxylic acids and derivatives:

1. A preview of Carbonyl Compounds
2. Aldehydes and Ketones: Nucleophilic Addition Reactions
3. Carboxylic Acids and Nitriles
4. Carboxylic Acid Derivatives: Nucleophilic Acyl Substitution Reactions
5. Carbonyl Alpha-Substitution Reactions
6. Carbonyl Condensation Reactions

Amines and other nitrogen functions

Primary, secondary and tertiary amines, amine basicity, synthesis of amines by substitution and reduction reactions, reactions of amines - alkylation, Hofmann exhaustive methylation, acylation, preparation of diazonium compounds - and their use in synthesis; nitro compounds.

4. TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face to face.
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of powerpoint presentation in teaching. Use of eclass platform (eclass.upatras.gr)
TEACHING METHODS *The manner and methods of teaching are described in detail.* *Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.* *The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS*	see table below

Activity	*Semester workload*
Lectures (3 contact hours per week x 13 weeks) Tutorials (1 contact hour per week x 13 weeks – Analysis of problem solving strategy and solution of representative problems)	52
Two (2) progress examinations, one at the middle (mid-term) and one the end of semester (2 contact hours for each exam)	4
Final examination (3 contact hours)	3
Hours for private study of the student	66
Course total	***125***

STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	1. Optionally, two (2) progress examinations, one at the middle and one the end of semester (mid-term). Minimum passing grade for each: 5. 2. Written examination after the end of the semester. Minimum passing grade: 5.

5. ATTACHED BIBLIOGRAPHY

1. L. G. Wade JR, “Organic Chemistry”, Translation to Greek: D. Komiotis et al, A. Tziolas and Sons Publications, 2010.
2. J. McMurry, “OrganicChemistry”, Translation to Greek: A. Varvoglis, M. Orfanopoulos, I. Smonou et al, University of Crete Publications, 2012.
3. Devid Klein, “OrganicChemistry”, Translation to Greek: G. Kokotoset al, Utopia Publications, 2015.
4. T. Mavromoustakos, T Tselios, K. Papakonstantinou, “Basic Pronciples of Organic Chemistry”, in Greek language,Symemtria Publications, 2014.
5. Clayden, N. Greeves, S. Warren, P. Wothers, “Organic Chemistry”, Oxford University Press, Oxford, 2001.

4th Semester (IV) (first applied in 2017-18)

Spectroscopy of Organic Compounds – Experimental Organic Chemistry-1

1. GENERAL

SCHOOL	NATURAL SCIENCES
ACADEMIC UNIT	CHEMISTRY
LEVEL OF STUDIES	UNDERGRADUATE

COURSE CODE	**XA 404**	**SEMESTER**	**4th**
COURSE TITLE	SPECTROSCOPY OF ORGANIC COMPOUNDS - EXPERIMENTAL ORGANIC CHEMISTRY 1		

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures	2	5
Seminars	2	
Laboratory work	4	
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Field of Science (Spectroscopy of Organic Compounds) and Skills Development (Experimental Organic Chemistry-1)
PREREQUISITE COURSES:	**Spectroscopy of Organic Compounds:** Typically, there are not prerequisite course. Essentially, the students should possess knowledge of Organic Chemistry and basic knowledge of General Chemistry and Physics. **Experimental Organic Chemistry-1:** Typically, there are not prerequisite course. The students should possess knowledge of Organic Chemistry obtained through the previously attended courses.
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek. Teaching may be however performed in English in case foreign students attend the course.
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	

2. LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

By the end of this course the student will be able to:

SPECTROSCOPY OF ORGANIC COMPOUNDS

Use (IR), ^{13}C και ^{1}H nuclear magnetic resonance (NMR), separately or in combination with each other, or with additional information from ultraviolet (UV)/Visible (vis) spectroscopy, mass spectrometry (MS), analytical data or descriptive chemistry, to identify structural features or complete structures of 'unknown' molecules. Determine a molecular formula either from the accurate mass of a molecular ion or from the isotope peak intensities. Calculate a 'double bond equivalent' from a molecular formula and propose possible structural characteristics thereof.

EXPERIMENTAL ORGANIC CHEMISTRY-1

Organize and execute syntheses of relatively simple organic molecules. More specifically, to:

1. Collect all the necessary information (compounds physical properties and hazards, literature information etc.) and then organize an organic synthesis/preparation.
2. Explain the role of the various reagents.
3. Assembly the various apparatuses required in a synthesis and carry out successfully both the synthetic

part and the separation and purification of the product(s) part of a synthesis. For this purpose, the student should have been acquainted with the theory and practice of techniques such as extraction, filtration, refluxing, distillation, recrystallization,etc.

4. Use spectroscopic methods (UV-Vis, IR, NMR and MS) for identifying the product(s).
5. Processing and present the results of the syntheses he/she carried out, such as yields, mechanisms, improvement of synthetic routes, etc.

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology	*Project planning and management*
Adapting to new situations	*Respect for difference and multiculturalism*
Decision-making	*Respect for the natural environment*
Working independently	*Showing social, professional and ethical responsibility and sensitivity to gender issues*
Team work	*Criticism and self-criticism*
Working in an international environment	*Production of free, creative and inductive thinking*
Working in an interdisciplinary environment	*Others*
Production of new research ideas	

By the end of this course the student will, furthermore, have developed the following skills (general abilities):

1. Ability to exhibit knowledge and understanding of the essential facts, concepts, theories and applications which are related to Spectroscopy of Organic Compounds.
2. Ability to prepare and carry-out the synthesis and characterization of simple organic molecules.
3. Ability to apply this knowledge to the solution of non-familiar problems.
4. Ability to apply this knowledge to the solution of new compounds.
5. Study skills needed for continuing professional development.
6. Ability to interact with others in chemical or of interdisciplinary nature problems.

Generally, by the end of this course the student will, furthermore, have develop the following general abilities (from the list above):

Searching, analysis and processing of data and information, as well as using the necessary technologies
Adaptation to new situations
Decision making
Autonomous (Independent) work
Group work
Exercise of criticism and self-criticism
Promotion of free, creative and inductive thinking
Respect to natural environment
Work design and management

3. SYLLABUS

SPECTROSCOPY OF ORGANIC COMPOUNDS

1. Matter and Electromagnetic Irradiation.
2. UV-Vis Spectroscopy (theory– applications)
3. IR and Raman Spectroscopy (theory– applications)
4. MS Spectrometry: a) Description of the principle and the various ionization techniques (Electron Impact, Chemical Ionization, MALDI, ES, etc. b) Generally about molecular fragmentation in mass spectrometry and Fragmentation pathways of the various categories of compounds c) Examples – Applications.
5. Nuclear Magnetic Resonance (NMR) spectroscopy, chemical equivalence, the δ scale, chemical shift. ^{1}H NMR spectra, integration, spin-spin coupling, the n+1 rule. ^{13}C NMR Spectroscopy, multiplicity in off-resonance spectra.
6. Combinatorial use of the above spectroscopic/spectrometric techniques for the identification of 'unknown' organic compounds.

EXPERIMENTAL ORGANIC CHEMISTRY-1

1. Introductory concepts of the Organic Chemistry Laboratory and description of techniques.

2. Preparation of tert-butyl chloride. 3. Preparation of acetanilide. 4. Preparation of cyclohexanone oxime. 5. Canizzarro reaction. 6. Nitration of Acetanilide. 7. Thin Layer Chromatography (separation of aminoacids). 8. Microscale reactions (Synthesis of Benzoine).

4. TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Lectures, seminars and laboratory work face to face.
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of Information and Communication Technologies (ICTs) (e.g. powerpoint) in teaching. Tutorials with exemplary analysis of problem solving in Spectroscopy. Tutorials where the experimental steps are thoroughly analyzed and combined with theory.
TEACHING METHODS *The manner and methods of teaching are described in detail.* *Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.* *The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS*	(see table below)

Activity	*Semester workload*
Lectures (2 contact hours per week x 13 weeks)	26
Tutorial (1 contact hour per week x 13 weeks – Analysis of problem solving strategy and solution of representative problems) Tutorial (1 contact hour per week x 13 weeks – Analysis of the laboratory experiments and combination with theory)	26
Laboratory work (4 contact hours per week x 13 weeks)	52
Final examination (3 contact hours)	3
Hours for private study of the student and preparation of home-works and preparation for the seminars and Laboratory	18
Course total	***125***

STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	**SPECTROSCOPY OF ORGANIC COMPOUNDS:** Written examination (50% of the final grade). Minimum passing grade: 5. **EXPERIMENTAL ORGANIC CHEMISTRY-1:** 1. Written tests of 15 minutes duration at the beginning of each new laboratory period (experiment). The mean mark from these tests consists the 25% of the final grade. 2. Reports following completion of each laboratory experiment. The mean mark from these tests consists the 25% of the final grade.

5. ATTACHED BIBLIOGRAPHY

1. L. G. Wade,Jr.,“Organic Chemistry”, Translation to Greek: D. Komiotis et al, A. Tziolas and Sons Publications, 2010.
2. J. McMurry, “OrganicChemistry”, Translation to Greek: A. Varvoglis, M. Orfanopoulos, I. Smonou et al, University of Crete Publications, 2012.
3. D. Papaioannou, G. Stavropoulos, T. Tsegenidis, "Spectroscopy of Organic Compounds", in Greek

language only, University of Patras Publications Centre, Patras, 2005. 4. Notes of lecturers in Greek.

Chemistry of Heterocyclic Compounds and Biomolecules

1. GENERAL

SCHOOL	NATURAL SCIENCES		
ACADEMIC UNIT	CHEMISTRY		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**XO 405**	**SEMESTER**	**4th**
COURSE TITLE	CHEMISTRY OF HETEROCYCLIC COMPOUNDS AND BIOMOLECULES		

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures	3	5
Seminars	1	
Laboratory work	-	
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Field of Science (Organic Chemistry)
PREREQUISITE COURSES:	There are no prerequisite courses. However, it is recommended that students should have at least a basic knowledge of General Chemistry and Organic Chemistry.
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek. Instruction may be given in English in case foreign students attended the course.
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	https://eclass.upatras.gr/courses/CHEM2056/

2. LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

At the end of this course the student should be able to:

CARBOHYDRATES AND NUCLEIC ACIDS

- Draw the Fischer projection of glucose and the chair conformation of the anomers of glucose from memory.
- Recognize the structures of other anomers and epimers of glucose, drawn as either Fischer projections or chair structures, by noticing the differences from the glucose structure..
- Name monosaccharides and disaccharides, and draw their structures from their names.
- Predict which carbohydrates mutarotate, which reduce Tollens reagent, and which undergo epimerization

and isomerization under basic conditions.

- Predict the products of the following reactions of carbohydrates: bromine in water, nitric acid, $NaBH_4$ or H_2/Ni, alcohols / H^+, CH_3I and Ag_2O, NaOH and dimethyl sulfate, acetic anhydride and pyridine, phenylhydrazine, Ruff degradation, Kiliani-Fischer synthesis.
- Use the information gained from these reactions to determine the structure of an unknown carbohydrate.
- Use the information gained from methylation and from periodic acid cleavage to determine the ring size.
- Draw the common types of glycosidiclinkages and recognize these linkages in disaccharides and polysaccharides.
- Recognize the structures of DNA and RNA and draw the structures of a ribonucleotide and a deoxyribonucleotide.

AMINO ACIDS, PEPTIDES, AND PROTEINS

- Name amino acids and peptides and draw the structures from their names.
- Use perspective drawings and Fischer projections to show the stereochemistry of D- and L- amino acids.
- Explain which amino acids are acidic, which are basic, and which are neutral. Use the isoelectric point to predict whether a given amino acid will be positively charged, negatively charged, or neutral at a given pH.
- Show how one of the following syntheses might be used to make a given amino acid: reductive amination, HVZ followed by ammonia, Gabriel—malonic ester synthesis, Strecker synthesis
- Predict products of the following reactions of amino acids: esterification, acylation, reaction with ninhydrin.
- Use information from terminal residue analysis und partial hydrolysis to determine the Structure of an unknown peptide.
- Show how solution-phase peptide synthesis or solid-phase peptide synthesis would be used to make a given peptide. Use appropriate protecting groups to prevent unwanted couplings.

LIPIDS

- Classify lipids both into the large classifications (such simple lipids, complex lipids, phospholipids etc.) and into the more specific classifications (such waxes, triglycerides, cephalins, lecithins, steroids, prostaglandins, terpenes, etc.)
- Predict the physical properties of fats and oils from their structures.
- Identify the isoprene units in terpenes and classify terpenes according to the number of carbon atoms.
- Predict the products of reactions of lipids with standard reagents. In particular, consider the reactions of the ester and olefinic groups or glycerides and the carboxyl groups of fatty acids.
- Explain how soaps and detergents work, with particular attention to their similarities and differences.

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology
Adapting to new situations
Decision-making
Working independently
Team work
Working in an international environment
Working in an interdisciplinary environment
Production of new research ideas

Project planning and management
Respect for difference and multiculturalism
Respect for the natural environment
Showing social, professional and ethical responsibility and sensitivity to gender issues
Criticism and self-criticism
Production of free, creative and inductive thinking
Others

By the end of this course the student will, have develop the following skills (general abilities):

1. Ability to demonstrate knowledge and understanding of the essential facts, concepts, theories and application which are related to Organic Chemistry and especially to the chemistry of heterocyclic compounds and biomolecules.
2. Ability to apply this knowledge and understanding to problem-solving in wider Organic Chemistry issues.

3. Ability to expand and apply methodology to the solution of more complex problems.
4. Study skills needed for continuing academic and professional development.
5. Ability to interact with others in chemistry or interdisciplinary problems.

Generally, by the end of this course the students should develop the following general skills:

Searching, analysis and synthesis of facts and information, as well as using the necessary technologies
Adaptation to new knowledge and combination of various concepts of chemistry
Decision making
Autonomous (Independent) work
Opportunity to assess the course and self-assessment
Promotion of free, creative and inductive thinking

3. SYLLABUS

CARBOHYDRATES AND NUCLEIC ACIDS

- Introduction
- Classification of Carbohydrates
- Monosaccharides
- D-L Sugars, Diastereomers, Epimers
- Cyclic Structures of Monosaccharides
- Anomers of Monosaccharides; Mutarotation
- Reactions of Monosaccharides: Side Reactions in Base, Reduction of Monosaccharides, Oxidation of Monosaccharides; Reducing Sugars, Formation of Glycosides, Ether and Ester Formation, Reactions with Phenylhydrazine, Chain Shortening: The Ruff Degradation, Chain Lengthening: The Kiliani-Fischer Synthesis
- Fischer's Proof of the Configuration of Glucose
- Determination of Ring Size; Periodic Acid Cleavage of Sugars
- Disaccharides
- Polysaccharides
- Nucleic Acids: Introduction
- Ribonucleosides and Ribonucleotides
- The Structure of Ribonucleic Acid
- Deoxyribose and the Structure of Deoxyribonucleic Acid
- Additional Functions of Nucleotides

AMINO ACIDS, PEPTIDES, AND PROTEINS

- Structure and Stereochemistry of the *a*-Amino Acids
- Acid-Base Properties of Amino Acids
- Isoelectric Points and Electrophoresis
- Synthesis of Amino Acids: reductive amination, HVZ followed by ammonia, Gabriel—malonic ester synthesis, Strecker synthesis
- Resolution of Amino Acids
- Reactions of Amino Acids: esterification, acylation, reaction with ninhydrin.
- Structure and Nomenclature of Peptides and Proteins
- Peptide Structure Determination
- Solution-Phase Peptide Synthesis
- Solid-Phase Peptide Synthesis
- Proteins

LIPIDS

- Introduction
- Waxes
- Triglycerides
- Reactions of Lipids: hydrogenation of glycerides, Saponification of Fats and Oils, transesterification; biodiesel
- Soaps and Detergents

- Phospholipids, Steroids, Prostaglandins, Terpenes

HETEROCYCLES

- Definition, Diversity and Categorisation of Heterocycles

Nomenclature

- Empirical names
- Method of Substitution
- Hantzsch-Widman system (IUPAC)
- Similarities and differences in reactivity between cyclic and aliphatic analogues

3- and 4--membered heterocycles

- Structure, stereochemistry and reactivity
- Syntheses of epoxides aziridines and β-lactams

Cyclisation reactions

- Kinetics and stereoelectronic effects in heterocyclisations
- Baldwin rules
- The Ring Closing Metathesis reaction in the synthesis of heterocycles
- 1,3 dipolar cycloadditions

5-membered aromatic heterocycles

- Structure, electronic properties
- Degree of aromaticity - aromatic *vs* diene behaviour
- Reactivity and regioselectivity in Electrophilic aromatic substitution reactions
- Reactivity and regioselectivity in Nucleophilic aromatic substitution reactions
- Acidity and Basicity of azoles
- Deprotonation of ring-carbon atoms and side chains
- Syntheses of 5-membered aromatic heterocycles

6-membered aromatic heterocycles

- Structure, electronic properties, nucleophilicity and basicity of azines
- Regioselectivity in Electrophilic aromatic substitution reactions
- Regioselectivity in Nucleophilic aromatic substitution reactions
- The Chichibabin reaction
- Reduction of pyridine rings - NAD/NADH
- Reactivity of substituents - similarities with benzene analogues
- Structure, electronic properties and reactivity of pyridine oxide
- Syntheses of pyridines, pyrazines and pyridazines

Fused aromatic heterocycles

- Nomenclature
- Structure and Reactivity of Indole, Quinoline and Isoquinoline
- Regioselectivity in Electrophilic aromatic substitution reactions
- Regioselectivity in Nucleophilic aromatic substitution reactions
- Syntheses of fused aromatic heterocycles.

4. TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Physical presence in Lectures and seminars.
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of Information and Communication Technologies (ICTs) (powerpoint) in Lectures. Course lectures, in the form of ppt or pdf files, are uploaded in the internet (https://eclass.upatras.gr/courses/CHEM2056/), from where the students can be freely downloaded using password. Communication with the students is established either through mail or through the webpage of the Chemistry Department.
TEACHING METHODS	***Activity*** / ***Semester***

The manner and methods of teaching are described in detail. *Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.* *The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS*		***workload***
	Lectures (3 contact hours per week x 13 weeks)	39
	Seminars (1 contact hour per week x 9 weeks) - solving of representative problems	9
	Half-term evaluations (2, one in the middle and the other at the end of the semester, 2 contact hours each)	4
	Final written examination (3 contact hours)	3
	Private study time of the student and preparation for the half-term evaluations and final examination	70
	Course total	***125***

STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	1. Optionally, at least one, half-term written examinations, the first one in the chapter of Biomolecules and the second in the chapter of heterocycles (immediately after the end of the semester). It is prerequisite that the students should at least obtain the grade 4 in the first half-term examination in order to be allowed to participate in the second one. 2. Written examination at the end of the semester - final mark, unless the student passed in half-term examinations. Minimum passing grade: 5. 3. The half-term examinations and the final written examination take place in the Greek language and for the foreign students (for example, ERASMUS students) in the English language. The assessment structure described above focuses on problem solving by combining the concepts and theories taught.

5. ATTACHED BIBLIOGRAPHY

1. J. McMurry, "Organic Chemistry", Translation to Greek: A. Varvoglis, M. Orfanopoulos, I Smonou, et al, University of Crete Publications, 2012.
2. L. G. Wade,Jr.,"Organic Chemistry", Translation to Greek: D. Komiotis, et al, A. Tziola and Sons Publications, 2010.
3. J. Clayden, N. Greeves, S. Warren, "Organic Chemistry", Vols I and II, Translation to Greek: G. Kokotos et al, Utopia Publications, 2017.
4. Notes from the teachers

Instrumental Chemical Analysis-2

1. GENERAL

SCHOOL	NATURAL SCIENCES		
ACADEMIC UNIT	CHEMISTRY		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**XA 454**	**SEMESTER**	**4th**
COURSE TITLE	INSTRUMENTAL CHEMICAL ANALYSIS-2		

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures	3	10
Seminars	1	
Laboratory work	3	

Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Field of Science (Analytical Chemistry)
PREREQUISITE COURSES:	There are no prerequisite courses. It is however recommended that students have basic knowledge of Physics, Organic chemistry, Qualitative analysis and Quantitative analysis.
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek. However, the course can be taught in English if foreign students enrolled.
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	http://www.chem.upatras.gr, http://eclass.upatras.gr

2. LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

At the end of this course the student will know:

1. Properties of electromagnetic radiation. Parts of optical instruments.
2. UV/Vis molecular spectroscopy: Transmittance and absorbance measurements. Beer'sLaw. Instrumentation.
3. Applications of UV/Vis molecular spectroscopy: Requirements for absorption at the UV/Vis range. Applications in qualitative and quantitative analysis. Photometric titrations.
4. Molecular luminescence spectroscopy: Theory of fluorescence and phosphorescence. Instrumentation. Applications and luminescence methods. Chemiluminescence.
5. Infrared absorption spectroscopy: Theory, instrumentation and applications.
6. Atomic absorption and atomic fluorescence spectroscopy: Atomization techniques, instrumentation for atomic absorption, interferences, analytical techniques in atomic absorption spectroscopy, atomic fluorescence spectroscopy.
7. Atomic emissions pectroscopy: Atomic emission spectroscopy based on plasma sources.
8. Atomic mass spectrometry: mass spectrometry (general), inductively coupled plasma/mass spectrometry.
9. Molecular mass spectrometry: mass spectra, various ion sources (electron impact, chemical ionization, field desorption, etc), Instrumentation for Mass Spectrometry. Mass analyzers (magnetic sectors, quadruple, time of flight, etc). MALDI and Electrospray Ionization. Applications of MS to the identification and quantification of a plethora of analytes. Tandem MS. Coupling of chromatography with mass spectrometry. Inductively coupled plasma-mass spectrometry (ICP-MS).
10. Automated methods of analysis. Principles, Instrumentation and Applications.

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology	*Project planning and management*
Adapting to new situations	*Respect for difference and multiculturalism*
Decision-making	*Respect for the natural environment*
Working independently	*Showing social, professional and ethical responsibility and sensitivity to gender issues*

Team work	*Criticism and self-criticism*
Working in an international environment	*Production of free, creative and inductive thinking*
Working in an interdisciplinary environment	*Others*
Production of new research ideas	

At the end of the course the student will have further developed the following skills/competences:

1. Critical knowledge of the advantages and disadvantages of various spectroscopic techniques.
2. How can we choose a spectroscopic technique in order to address a particular analytical challenge in real samples?
3. Quantitative aspects of spectroscopic techniques, including calibration.
4. Effect of interferences and how to avoid them.
5. How can we choose a particular instrument (cost versus performance).
6. Advantages and disadvantages of various instruments.

3. SYLLABUS

1. Introduction to spectroscopic techniques: Properties of electromagnetic radiation. Parts of optical instruments.
2. UV/Vis molecular spectroscopy: Transmittance and absorbance measurements. Beer'sLaw. Instrumentation.
3. Applications of UV/Vis molecular spectroscopy: Requirements for absorption at the UV/Vis range. Applications in qualitative and quantitative analysis. Photometric titrations.
4. Molecular luminescence spectroscopy: Theory of fluorescence and phosphorescence. Instrumentation. Applications and luminescence methods. Chemiluminescence.
5. Infrared absorption spectroscopy: Theory, instrumentation and applications.
6. Atomic absorption and atomic fluorescence spectroscopy: Atomization techniques, instrumentation for atomic absorption, interferences, analytical techniques in atomic absorption spectroscopy, atomic fluorescence spectroscopy.
7. Atomic emission spectroscopy: Atomic emission spectroscopy based on plasma sources. Multielement analysis.
8. Atomic mass spectrometry: Mass spectrometry (general), Inductively coupled plasma/mass spectrometry.
9. Molecular mass spectrometry: mass spectra, various ion sources (electron impact, chemical ionization, field desorption, etc), Instrumentation for Mass Spectrometry. Mass analyzers (magnetic sectors, quadruple, time of flight, etc). MALDI and Electrospray Ionization. Applications of MS to the identification and quantification of a plethora of analytes. Tandem MS. Coupling of chromatography with mass spectrometry. Inductively coupled plasma-mass spectrometry (ICP-MS).
10. Automated methods of analysis. Instrumentation. Flow injection analysis, Discrete automated analyzers. Analysis based on multilayered films.

Laboratory Exercises:

- Potensiometry.
- Electrogravimetric analysis.
- Conductimetry.
- UV/Vis Spectroscopy (quantitative analysis, standard addition method).
- UV/Vis Spectroscopy (binary mixtures).
- Photometric titrations.
- Fluorescence spectroscopy.
- Atomic emission (Flame photometry).
- Gas chromatography.
- HPLC ion exchange.

- HPLCreverse phase.
- Automated titration.
- Kinetic photometric determination of an enzyme.

4. TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Lectures, tutorials and laboratory practice
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of Information and Communication Technologies (ICTs) (powerpoint) in Lectures. Communication with the students via e-mail or the e-class electronic platform: http://eclass.upatras.gr. Personal Codes are given to the students with their registration at the department. Seminars. Problems are solved in an exemplary way summarizing before the theory behind each problem.
TEACHING METHODS *The manner and methods of teaching are described in detail.* *Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.* *The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS*	see table below

Activity	*Semester workload*
Lectures (3 contact hours per week x 13 weeks)	39
Seminars (1 contact hour per week x 13 weeks) - solving representative problems	13
Laboratory exercises (3 contact hours per week x 12 weeks)	36
Final written examination (3 contact hours)	3
Final written examination of the lab (1 contact hour)	1
Private study time of the student and preparation for the half-term evaluations and final examination	158
Course total	***250***

STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	One written examination at end of Semester 80% of the final grade. One written examination for the Laboratory at end of Semester 20% of the final grade. Minimum passing grade: 5.

5. ATTACHED BIBLIOGRAPHY

1. D.A. Skoog, F.J. Holler, T.A. Nieman, "Principles of Instrumental Analysis", 6th Edition, Thomson Brooks Cole Publications, 2007.
2. T.P. Hadjiioannou and M.A. Kouppari, "Instrumental Analysis", Mavrommatis Publications, 2003.
3. D.C. Harris, "Quantitative Chemical Analysis", 8th Edition, W. H. Freeman and Company Publications, 2010.

Physical Chemistry-3

1. GENERAL

SCHOOL	NATURAL SCIENCES

<table>
<tr><td>ACADEMIC UNIT</td><td colspan="3">CHEMISTRY</td></tr>
<tr><td>LEVEL OF STUDIES</td><td colspan="3">UNDERGRADUATE</td></tr>
<tr><td>COURSE CODE</td><td>XA 434</td><td>SEMESTER</td><td>4th</td></tr>
<tr><td>COURSE TITLE</td><td colspan="3">PHYSICAL CHEMISTRY-3</td></tr>
<tr><td colspan="2">INDEPENDENT TEACHING ACTIVITIES
if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits</td><td>WEEKLY TEACHING HOURS</td><td>CREDITS</td></tr>
<tr><td colspan="2">Lectures</td><td>3</td><td>10</td></tr>
<tr><td colspan="2">Seminars</td><td>1</td><td></td></tr>
<tr><td colspan="2">Laboratory work</td><td>4</td><td></td></tr>
<tr><td colspan="2">Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).</td><td></td><td></td></tr>
<tr><td>COURSE TYPE
general background, special background, specialised general knowledge, skills development</td><td colspan="3">Field of Science and Skills Development</td></tr>
<tr><td>PREREQUISITE COURSES:</td><td colspan="3">Typically, there are not prerequisite course.
Essentially, the students should possess knowledge provided through the previously taught theoretical course ‘'Physical Chemistry – 1’’</td></tr>
<tr><td>LANGUAGE OF INSTRUCTION and EXAMINATIONS:</td><td colspan="3">Greek. Teaching may be however performed in English in case foreign students attend the course.</td></tr>
<tr><td>IS THE COURSE OFFERED TO ERASMUS STUDENTS</td><td colspan="3">YES</td></tr>
<tr><td>COURSE WEBSITE (URL)</td><td colspan="3"></td></tr>
</table>

2. LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

By the end of this course the student will be able to:

1. Define the chemical equilibrium constant of a reaction and derive its relation to temperature and pressure.

2. Answer the following questions:

a) How fast does a chemical reaction occur?

b) What factors affect the rate of chemical reactions?

c) What is the mechanism that follows chemical reactions?

3. Define the factors that influence the rate of enzyme reactions.

4. Define parameters such as activity, activity coefficient, mean activity coefficient of ions in solution and describe the interactions between the different species in electrolyte solutions.

5. a) Describe the electrode-electrolyte interface.

b) Represent electrochemical cells.

c) Predict when electrochemical reactions become spontaneous.

d) Define the electrochemical equilibrium.

e) Define the dependence of the ionic potential on the activities of the ions.

6. Define the rate of electrochemical reactions and describe its relationship to the potential difference of electrodes.

7. Prepare and execute laboratory experiments related to the contents of the course.

8. Prepare technical reports after numerical calculations based on experimental data and carry out scientific conclusions.

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology

Adapting to new situations

Decision-making

Working independently

Team work

Working in an international environment

Working in an interdisciplinary environment

Production of new research ideas

Project planning and management

Respect for difference and multiculturalism

Respect for the natural environment

Showing social, professional and ethical responsibility and sensitivity to gender issues

Criticism and self-criticism

Production of free, creative and inductive thinking

Others

By the end of this course the student will further develop the following skills:

1. Ability to exhibit knowledge and understanding of the essential facts, concepts, theories and applications which related to Physical Chemistry and especially of Chemical Equilibrium, Chemical Kinetics and Electrochemistry.

2. Ability to apply this knowledge and understanding to the solution of problems related to Material Science, Environment, Food Science, Biology, Pharmacy and Medicine.

3. Study skills needed for continuing professional development.

4. Ability to prepare and execute laboratory experiments related to Physical Chemistry.

5. Ability to interact with others in chemical or of interdisciplinary problems.

Generally, by the end of this course the student will, furthermore, have develop the following general abilities:

Searching, analysis and synthesis of facts and information, as well as using the necessary technologies

Adaptation to new situations

Decision making

Autonomous (Independent) work

Group work

Exercise of criticism and self-criticism

Promotion of free, creative and inductive thinking

Respect to natural environment

Work design and management

3. SYLLABUS

1. *Chemical Equilibrium*

   Chemical equilibrium constants and their dependence on temperature and pressure. Representative examples of chemical equilibrium. Chemical equilibrium in biological reactions.

2. *Chemical Reaction Kinetics*

   Kinetic equations. Define reaction order and rate constant of chemical reactions. Kinetic equations from the mechanism of the reaction. Steady state approximation. Kinetic equations for consecutive reactions. The kinetics of complex reactions.

3. *Kinetic of enzyme actions*

   Effect of concentration, pH and temperature on the rate of enzyme action. Michaelis-Menten mechanism of enzyme action.

4. *Conductivity and Ionic Equilibrium*

Conductivity. Transport numbers. Conductivity and electrical mobility of ionic species. Ionic equilibrium. Buffer solutions. Indicator solutions.

5. *Electrochemical cells*

   Electrodes and electrochemical cells. Electrochemical reactions. Thermodynamics of electrodes and electrochemical potential. Membrane potentials. Definition of *pK* of an acid or base and the pH of asolution. Potentiometric titrations.

6. *Electrochemical Kinetics*

   Electric double layer. Rate of electrochemical reactions. Overpotential. Polarography. Corrosion.

7. *Experimental physical chemistry.*

   Laboratory work dealing with subjects of Chemical Thermodynamics, Chemical Equilibrium, Chemical Kinetics and Electrochemistry.

4. TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Lectures, seminars and laboratory work face to face.
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of Information and Communication Technologies (ICTs) (e.g. power point) in teaching.
TEACHING METHODS *The manner and methods of teaching are described in detail.* *Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.* *The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS*	see table below

Activity	*Semester workload*
Lectures (3 contact hours per week x 13 weeks)	39
Seminars (1 contact hour per week x 13 weeks) - solving of representative problems	13
Laboratory work (4 contact hours per week x 13 weeks)	52
Final examination (3 contact hours)	3
Hours for private study of the student and preparation of technical reports for each laboratory experiment.	143
Course total	***250***

STUDENT PERFORMANCE EVALUATION

Description of the evaluation procedure

Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other

Specifically-defined evaluation criteria are given, and if and where they are accessible to students.

The course is consisted of theoretical (lecture and seminars) and laboratory sessions.

Theoretical session

1. Optionally two (2) written examinations during the semester.
2. Written examination after the end of the semester.

   Minimum passing grade for the theoretical session: 5

Laboratory session

1. a. Oral examination at the beginning of each new laboratory period (experiment). The mean mark from these examinations consists the 50% of the final grade of the laboratory session.

   a. Written report for each laboratory experiment. The mean mark of the reports consists the 50% of the final grade of the laboratory session.

   Minimum passing grade for the experimental session: 5

The final course grade is calculated as follows:

Grade of the theoretical session (70%) and grade of the laboratory session (30%). Compulsory passing grade for both theoretical and

	laboratory sessions.

5. ATTACHED BIBLIOGRAPHY

1. G. Karaiskakis, "*Physical Chemistry*", in Greek language only, Travlos Publications, 1998.
2. P. Atkins, J. De Paula, "*Physical Chemistry*», 8th Edition, Oxford University Press, 2006.
3. N. Katsanos "*Physical Chemistry: Basic Consideration*", 3rd Edition, in Greek language only, Papazisis Publications, 1999.
4. N. Katsanos, "*Physical Chemistry Laboratory Textbook*", PartsI&II, in Greek language only, University of Patras Publications, 2006.
5. G. Karaiskakis, N. Klouras, E. Manesi-Zoupa, "*Chemistry Laboratory Textbook*", in Greek language only, Hellenic Open University Publications, 2003.
6. R.J. Sime, "*Physical Chemistry: Methods-Techniques-Experiments*", (Saunders Golden Sunburst Series), Saunders College Publishing, 1998.
7. A.D. Mc Quarrie, J.D. Simon, ''*Physical Chemistry. A Molecular Approach*''. University Science Book, 1997.

5th Semester (V)

Organic Chemistry of Functional Groups-II

Course title	Organic Chemistry of Functional Groups II
Course code	**XO503**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	3rd
Semester	5th
ECTS credits	10
Name of lecturer(s)	Lectures: Assoc. Prof.C. Athanassopoulos,Assoc. Prof. Th. Tselios Laboratory Course: Assist. Prof. G. Rassias Laboratory: Prof.K. Barlos, Assoc. Prof. D. Gatos, Assoc. Prof. Th. Tselios, Prof. D. Papaioannou, Prof. Th. Tsegenidis, Assoc. Prof. G. Tsivgoulis, Assoc. Prof. C. Athanassopoulos, Assist. Prof. G. Rassias
Learning outcomes	At the end of this course the student should be able to: *Aldehydes–ketones, Carboxylic acids and derivatives:* 4. Present the most important reactions-methods for the preparation of carbonyl compounds and reactions involving inter-conversion of carbonyl groups. Present the most important reactions with the presence of carbonyl compounds. 5. Evaluate chemical methods and propose-apply methods for the synthesis and inter-conversion of carbonyl compounds ortheirconversiontootherorganiccompounds. 6. Presents the applications and use of carbonyl compounds. *Amines and other nitrogen functions* Distinguish between the behaviour of amines as nucleophiles and bases, and between nitrogen in sp3, sp2 and sp hybridisation. Account for the basicity of amines, and the reduced basicity of amides. Exploit the usefulness of diazonium compounds in the synthesis of substituted benzene derivatives. At the end of this laboratory course the student should be able to organize and perform the synthesis of simple organic molecules. In particular, he should be able to: 1) Collect all the necessary information (hazards, properties of compounds,

	bibliography of synthesis etc.) and analyze the procedure in simple experimental steps. 2) Explain the role of all the reagents. 3) Assembly all type of equipments necessary in classical organic synthesis and perform successfully the synthesis as well as the isolation and purification of the products. To accomplish these tasks he should know the various techniques used usually in organic synthesis like extraction, filtration, distillation, recrystalization etc. 4) Processing the data and presenting the results of his experiments (yields, notes, improvements etc.). 5) Use environmentally friendly reagents, solvents and experimental techniques (Green Chemistry).
Competences	At the end of the course and the laboratory the student will have further developed the following skills/competences: 1) Ability to demonstrate knowledge and understanding of essential facts, concepts, principles and theories relating to carbonyl compounds. 2) Ability to understand essential facts, concepts, principles and theories relating to Heterocycle Chemistry and Chemistry of Natrural Products. 3) Ability to apply such knowledge and understanding to the solution of qualitative and quantitative problems of an unfamiliar nature. 4) Ability to adopt and apply methodology to the solution of unfamiliar problems. 5) Study skills needed for continuing professional development. 6) Ability to interact with others on inter or multidisciplinary problems. 7) Ability to understand essential facts, concepts, and techniques relating to the Synthesis of Simple Organic Molecules. 8) Ability to apply such knowledge for the synthesis of new molecules.
Prerequisites	There are no prerequisite courses**.** It is however recommended that students should have at least a basic knowledge of Organic Chemistry.
Course contents	*Aldehydes –ketones, Carboxylic acids and derivatives:* 7. A preview of Carbonyl Compounds. 8. Aldehydes and Ketones: Nucleophilic Addition Reactions. 9. Carboxylic Acids and Nitriles. 10. Carboxylic Acid Derivatives: Nucleophilic Acyl Substitution Reactions. 11. Carbonyl Alpha-Substitution Reactions. 12. Carbonyl Condensation Reactions. *Amines and other nitrogen functions:* Primary, secondary and tertiary amines, amine basicity, synthesis of amines by substitution and reduction reactions, reactions of amines - alkylation, Hofmann exhaustive methylation, acylation, preparation of diazonium compounds - and their use in synthesis; nitro compounds, ureas. *Laboratory exercises* 1. Introductory concepts for a Laboratory and description of the various techniques and introduction to Green Chemistry. 2. Synthesis of 1,2,3,4 tetrahydrocarbazole. 3. Reduction of camphor. 4. Synthesis of aniline from the reduction of nitrobenzole. 5. Synthesis of orange color of b-naphthol. 6. Diels-Aldersreaction with microwaves (Green Chemistry). 7. Barbier reaction (type Grignard) in water solution (GreenChemistry). 8. Synthesis of benzocaine.

Recommended reading	1. L.G. Wade, "Organic Chemistry", 7th edition, Greek translation: D. Komiotis, A. Vronteli, S. Manta, Tziola Technical Publications. 2. J. McMurry, "Organic Chemistry", Volumes I and II, translation in Greek of the original English text, Creta University Press, 1999. 3. D. Papaioannou, G. Stayropoulos, Th. Tsegenidis, "Notes on experimental organic chemistry", Publications of University of Patras. 4. C. Poulos, "Notes of experimental Green Chemistry", Publications of University of Patras, 2010.
Teaching and learning methods	Lectures using slides for overhead projector and/or power-point. Problem-solving seminars.
Assessment and grading methods	Writtenexamination (100% of the final mark) Laboratory: 1 Test before any experiment (30% of the final mark). 2 Performance of the student during the experiments and yield of the reactions (30% of the final mark). 3 Writtenexamination (40% of the final mark). Greek grading scale: 1 to 10. Minimum passing grade: 5. Grades ≤3 correspond to ECTS grade F. Grade 4 corresponds to ECTS grade FX. For the passing grades the following correspondence normally holds: 5 ↔ E, 6 ↔ D, 7 ↔ C, 8 ↔ B and ≥9 ↔ A
Language of instruction	Greek

Physical Chemistry-4

Course title	Physical Chemistry-4
Course code	**XA535**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	3rd
Semester	5th
ECTS credits	5
Name of lecturer(s)	Lectures: Assist. Prof. Ch. Matralis Laboratory: Assist. Prof. Ch. Matralis, Prof. E. Dalas, Assoc. Prof. A. Koliadima, Assoc. Prof. E. Papaeftymiou
Learning outcomes	In brief, at the end of this course the student should be able to: • Define basic concepts in the fields of Statistical Thermodynamics, Electric properties of molecules, Intermolecular Forces, and Colloid Chemistry. • State the two axioms of Statistical Thermodynamics and discuss the objectives of this branch of Physical Chemistry • Explain the physical meaning of the Boltzmann distribution and the partition functions. • Describe the genesis of the induced dipole moment. • Explain the influence of the electric field frequency on the polarizibility. • Describe and discuss experimental procedures for the determination of the permanent dipole moment and polarizibility.

	• State the various factors affecting the potential energy of interaction. • Present examples of properties of macroscopic systems which are controlled by intermolecular forces and describe the kind of interactions which cause these forces. • Describe and discuss methods for preparing colloidal solutions, for determining the size of colloidal particles and for determining the molecular weight of macromolecules.
Competences	At the end of this course the student will have further developed a number of skills-competences. Examples of such skills comprise the ability of the student to: • Calculate the molecular partition functions for a number of simple cases (two-state system, harmonic oscillators, particle-in–a-box, etc.) • Calculate the canonical partition functions for macroscopic (N,V,T) systems of independent particles. • Calculate the thermodynamic properties of atomic crystals and of macroscopic (N,V,T) systems of independent particles using the methods of Statistical Thermodynamics. • Choose the correct relationship among relative permittivity and electric properties of molecules, depending on the nature of the molecules and of the electric field. • Recognize whether a given interaction is long- or short-ranged. • Assess the strength of a given intermolecular interaction in relation to the Brownian motion. • Recognize the kind of interactions which may develop between two particles and express the resulting potential energy of interaction. • Solve exercises and problems related to the material taught in this course. Concerning the skills which the student is expected to develop through practical work in the Physical Chemistry Laboratory IV, those comprise the ability to: • Work safely in a chemical lab. • Carry out scientific experiments aiming to the determination of the values of various physicochemical properties. • Use standard mathematical analyses to correctly describe the numerical significance of experimental results. • Communicate successfully in written reports the experimental procedure followed and the obtained results. • Work harmoniously with others during a collaborative experimental project.
Prerequisites	Although there are no prerequisite courses, it is strongly recommended that the students should have a good knowledge of what has been taught in the courses of Physical Chemistry and those of Mathematics during the previous semesters.
Course contents	*A. Statistical Thermodynamics* A1. Introduction to Statistical Thermodynamics – The objectives of Thermodynamics, Quantum Chemistry and Statistical Thermodynamics. – Energy distribution among the moleculesof a macroscopic (N,V,E) system of localized and independent molecules. – The principle of equal a priori probabilities. – Basic concepts (Instantaneous configurations, Statistical weights, Dominating configuration). A2. The Boltzmann distribution and the Molecular Partition Function – Calculation of populations for the Dominating configuration. – The Boltzmann distribution – Physical meaning. – The Molecular Partition Function – Physical meaning. – Energy states and energy levels. Degenerate states (Molecular Partition Function

	expressed as a sum over energy levels, Boltzmann distribution relative to energy levels). – Examples of calculation of Molecular Partition Function (Two levels systems, Harmonic oscillator, Particle-in-a-box, Thermal Wavelength of a molecule, Monatomic molecule in a three dimentional box). A3. Calculation of Thermodynamic properties from the Molecular Partition Function (q) – Internal energy (Calculation of the internal energy of a system comprised by one-dimensional harmonic oscillators). – The constant – volume heat capacity (C_V). – Einstein's model for an atomic crystal (Calculation of internal energy and heat capacity (C_V) of a crystalline element, Einstein's equation for constant – volume heat capacity (C_V) of atomic crystals). – Calculation of the Molecular Partition Function (q) by the direct summation of its terms (Examples of calculation of U and C_V. Variationof U and $C_V$with the temperature). – Entropy (Boltzmann' sequation for the Statistical Entropy. Entropy as a function of the Molecular Partition Function. The approxima-tion Ω=W, Calculation of the entropy of a crystalline element). – Historical background of the development of the Statistical Thermodynamics. A4. Macroscopic (N,V,T) systems of independent molecules – The concept of an Ensemble. – Basic kinds of Ensembles (Microcanonical, Canonical and Gand Canonical Ensembles). – First axiom of Statistical Thermodynamics (The principle of the equal a priori probabilities revisited). – First axiom of Statistical Thermodynamics (Ergodic hypothesis). – The method of ensembles of Gibbs (Application of the Gibbs method in the Canonical ensemble, Instantaneous configurations, Statistical weights and Dominating configuration of the Canonical ensemble). – The Boltzmann distribution in the Canonical ensemble. – The Canonical Partition Function (Calculation of the Canonical Partition Function (Q) from the Molecular Partition Function (q), Real macroscopic systems of independent and localized (or non-localized) molecules, Examples of calculation of the CanonicalPartitionFunction). – Calculation of thermodynamic properties for macroscopic (N,V,T) systems from the Canonical Partition Function (Internal energy, Constant-volume heat capacity, Entropy, Helmholtz energy, Pressure, Enthalpy, Gibbs energy). – Application for Ideal monatomic Gases (Sackur - Tetrode equation for the entropy, Chemical Equilibrium). *B. Electric Properties of Molecules and Intermolecular Forces* B1. Electric Properties of Molecules – Basic concepts (Electric Dipole, Electric Dipole Moment, Polar molecules, Permanent Electric Dipole Moment, Non-polar molecules, Induced Electric Dipole Moment, Polarization of a sample, Ferroelectric solids, Dielectrics). – Polar molecules (Diatomic, Polyatomic molecules). – Electronegativity and Electric Dipole Moment (Pauling and Mulliken scales of Electronegativity, Approximate relations between Electronegativity and Electric Dipole Moment for diatomic molecules). – Induced Electric Dipole Moment (Polarizability of a molecule, Polarizability volume, Anisotropy of the Polarizability, Electronic Polarizability, Distortion Polarizability and Orientation Polarizability, Debye - Langevin equation).

	– Influenceoffieldfrequency onPolarization. B2. Dielectric Constant and Electric properties of molecules – Dielectric Constant (Experimental determination of the Dielectric constant, Relation between Dielectric constant and Polarization of the sample). – Dielectric Constant and Electric properties of molecules (Low pressure gaseous samples, condensed samples). – Molar Polarization of a sample. – Debye and Clausius – Mossotti equations. – Experimental determination of Dipole Moment and Polarizabilities from measurements of the Dielectric constant (method description, examples and study cases). B3. Interactions – The concept of Interaction. – Kinds of Interactions in nature. – Potential Energy of Interaction and factors on which it depends. – Range of Interaction. – The concept of Force. B4. Intermolecular Forces – Historical background. – Significance of the Intermolecular Forces. – Influence of the medium. – Ion – Ion Interaction (PotentialEnergy, Range and Strength of interaction). – Energy of ionic crystal lattice. – Ion – Polar molecule Interaction (Potential Energy, Range and Strength of interaction). – Ions in Polar Solvents (Solvation, Solvation number, mean reorientation time, weakly and strongly Solvate ions, Primary Solvation Shell, Solvation zone). – Ion – Rotating Polar molecule Interaction (Mean Potential Energy of Interaction, Theorem of Potential Distribution, Range and Strength of interaction). – Interaction among Non-rotating Polar molecules (Potential Energy, Range and Strength of Interaction). – Interaction among Rotating Polar molecules - Keesom Interaction (Mean Potential Energy, Range and Strength of Interaction). – Polar molecule – Non-polar molecule Interaction (Pair of dipole – induced dipole interaction, Potential Energy, Range and Strength of Interaction). – Non-polar molecule - Non-polar molecule Interaction (Induced dipole – Induced dipole Interaction, London (Dispersion) Interaction, Potential Energy, London formula, Range and Strength of Interaction). – Hydrogen Bonding. *Γ. Introduction to Colloid Chemistry* – Basic Concepts, The colloidal state, Definitions, Classification of colloidal systems. – Preparation of colloidal systems (Dispersion methods, Aggregation methods). – Purification of colloidal systems. – Size of colloidal particles. – The number average molecular weight andthe weight average molecular weight. – Methods for determining the size of colloidal particles. – Methods for determining the molecular weight of macromolecules. – Electric properties of colloidal particles.

	– Suspensions. – Emulsions. *Laboratory of Physical ChemistryIV* Practice of students on eight out of a collection of laboratory exercises, which are based on the material taught in the four courses of Physical Chemistry. Examples of the exercises offered are: – Adiabatic Expansion of Gases (Determination of the Heat CapacityC_Vκαι$C_P$of gases). – Joule-Thomson Effect (Determination of the Joule-Thomson coefficient of gases). – Steam Distillation (Determination of themolecular weight of a substance non soluble in water). – Surface Tension of Solutions (Determination of theeffective cross sectional area of a molecule). – Adsorption from Solutions (Determination of the surface coverage of the solid by the adsorbed molecules). – IntrinsicViscosity (Determination of the molar mass of a polymer). – Electric Dipole Moment of Polar molecules in Solution (Determination of the Molar Polarization of dilute solutions of a polar substance in a non-polar solvent from capacitance measurements, Determination of the dipole moment of the solute molecules). – Influence of Ionic Strength on the Solubility. – Conductance of Solutions (Determination of the ionization constant of a weak electrolyte). – Temperature dependence of emf (Determination of the changes in Gibbs free energy, entropy and enthalpy). – Activity Coefficients from Cell Measurements. – Tafel diagram. – Galvanic Cell (Determination of the operation curve of a galvanic cell). – Atomic Absorption Spectroscopy (Quantitative analysis of calcium in water). – UV-Vis Spectroscopy (Determination of the energy and probability of a transition). – IR Spectroscopy (Vibration spectrum of SO_2, Determination of the vibrational contribution to the heat capacity C_V). – Light Scattering for Monitoring Particle Growth (Kinetics of formation of sulphur colloidal particles).
Recommended reading	1. P.W. Atkins, "Physical Chemistry", 6th Edition, Oxford University Press, 1999. 2. D.A. McQuarrie, J.D. Simon, "Physical Chemistry: A Molecular Approach", University Science Books, 1997. 3. E. Dalas, A. Chrisanthopoulos, "Experiments in Physical Chemistry IV", Publications of University of Patras. 4. D.P. Shoemaker, C.W. Garland, J.W. Nibler, "Experiments in Physical Chemistry", 8th edition, McGraw-Hill, 2008.
Teaching and learning methods	Lectures, team work during the problem-solving seminars and laboratory exercises.
Assessment and grading methods	1. Optional Assessment Tests (2 or 3 written tests of 2h duration per semester on the material of the course Physical Chemistry IV). A student may be exempted from the final exam if his/her grade, in all the optional assessment tests, is equal to or higher than a predefined grade (usually 6 or 7). In this case the student's mean in the grade of the optional assessment tests is taken as his/her grade for the final written examination. Otherwise, his/her mean grade in these tests is taken into account in the final written examination grade (by 30% - only during the first examination period and only if this increases the student's grade). 2. The assessment of students in the Lab is based, for each laboratory exercise, on the

	examination preceding the exercise (50%) and on the written report (50%) for the exercise. The final grade in the Lab is the mean of the student's grades in 8 exercises. 3. Final written examination on the material of the course Physical Chemistry IV. 4. The final grade for the course Physical Chemistry IV is calculated by the final grade in the Lab(30%) and the grade of the final written examination (70%). The student must have secured a minimum grade of 5 in both the Lab and the final written examination.
Language of instruction	Greek. Both, the practice of foreign students in the Lab as well as guidance for the study of the course Physical Chemistry IV may be done in English or French.

Biochemistry-1

Course title	Biochemistry-1(Structure and function of bio-molecules, Transduction and storage of energy, Cellular Signaling)
Course code	**XO510**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	3rd
Semester	5th
ECTS credits	5
Name of lecturer(s)	Prof. N. Karamanos, Assoc. Prof A. Theocharis, Assoc. Prof. A. Aletras
Learning outcomes	At the end of this course the student should be able to: 1. Know in general about the chemical composition, structure and function of basic biomolecules (carbohydrates, proteins, lipids, nucleic acids). 2. Know the classification of proteins, and the structure and function of the main members in each class. 3. Know the classification of enzymes, the determination of their kinetic constants, the general mechanisms of enzymatic reactions, and the modes of enzyme activity regulation. 4. Know the basic concepts of cellular signaling. 5. Present the pathway of light energy (solar energy) conversion into chemical energy in the form of various biomolecules. 6. Describe in general the pathways of oxidative release of energy from fuel molecules and its storage into reduced coenzymes, and the role of citric acid cycle (Krebs cycle) and glyoxylate cycle in this process. 7. Describe the pathway of energy release from reduced coenzymes through respiratory chain and storage of energy into ATP through oxidative phosphorylation.
Competences	At the end of the course the student will have further developed the following skills/competences: 1. Ability to demonstrate knowledge and understanding of essential facts, concepts, principles and theories relating to chemical composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids), transduction and storage of energy into fuel molecules, and energy release from them. 2. Ability to apply such knowledge and understanding to the solution of qualitative and quantitative problems of an unfamiliar nature. 3. Ability to adopt and apply methodology to the solution of unfamiliar problems. 4. Study skills needed for continuing professional development.

	5. Ability to interact with others on inter or multidisciplinary problems.
Prerequisites	There are no prerequisite courses. It is however recommended that students should have at least a basic knowledge of Organic Chemistry and General Biology.
Course contents	1. Protein structure and function. Amino acids and their acid-base properties. Primary, secondary, tertiary and quaternary structure of proteins. Physicochemical properties of proteins, methods of protein isolation, purification, separation and detection. Determination of protein primary structure. 2. Protein classification. a) Stuctural proteins (collagens, elastin, keratins). b) Functional proteins b1) Catalytic proteins (enzymes). Enzyme classification, kinetics of enzymatic reactions, mechanisms of enzymatic reactions, regulation of enzyme activity. b2) Transfer proteins. Hemoglobin, myoglobin, structure and function, cooperative effect. b3) Defensive proteins (antibodies). Structure and function, use of antibodies in the analysis. b4) Contractible proteins. Myosin, actin, structure and function. 3. Nucleic acids. Chemical composition and structure. The genetic information flow. 4. Lipids and cell membranes. Types of membrane lipids (phospholipids, glycolipids, cholesterol). Structure of cell membranes. The fluid mosaic model. 5. Carbohydrates. Chemical composition and structure. Oligosaccha-rides, polysaccharides, glycosaminoglycans. Glycoproteins, proteoglycans. 6. Signal transduction. Basic concepts. 7. Metabolism, basic concepts and design. ATP as the universal currency of free energy in biological systems. 8. Photosynthesis. The light reactions of photosynthesis. Photosystems I and II. The dark reactions-The Calvin cycle. C3 and C4 plants. 9. Oxidative release of energy from fuel molecules and its storage into reduced coenzymes. The central role of acetyl-coenzyme A. Citric acid cycle (Krebs cycle) and glyoxylate cycle. 10. Energy release from reduced coenzymes (respiratory chain) and storage of energy into ATP (oxidative phosphorylation).
Recommended reading	1. J.M. Berg, J.L. Tymoczko, L. Stryer, "Biochemistry", Volume I and II, Translation: A. Aletras, Th. Valkana, D. Drainas et al., Creta University Press, 2005. 2. D.L. Nelson, M.M. Cox, "Lehninger Basic Principles of Biochemistry", Volume I, II and III, Ed.: A.G. Papavasileiou, Medicinal Publications P.X. Pasxalidis, 2007 &2008. 3. C.A. Demopoulos, S. Antonopoulou, "Basic Biochemistry", 2nd revised edition, C.A. Demopoulos, S. Antonopoulou Publications, 2009. 4. J.G. Georgatsos, "Introduction to Biochemistry", 6th Edition, Giahoudi Publications, 2005.
Teaching and learning methods	Lectures using power-point presentations and/or slides for overhead projector. Self-test of students with multiple-choice questions. Problem-solving seminars for the instructive solution of problems in teams of 25 students.
Assessment and grading methods	Writtenexamination. Greek grading scale: 1 to 10. Minimum passing grade: 5. Grades ≤3 correspond to ECTS grade F. Grade 4 corresponds to ECTS grade FX. For the passing grades the following correspondence normally holds: 5 ↔ E, 6 ↔ D, 7 ↔ C, 8 ↔ B and ≥9 ↔ A

Language of instruction	Greek

Inorganic Chemistry-3 (Chemistry of 2nd and 3rd Row Metals and of Lanthanides)

Course title	Inorganic Chemistry-3 (Chemistry of 2nd and 3rd Row Metals and of Lanthanides)
Course code	**XA524**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	3rd
Semester	5th
ECTS credits	5
Name of lecturer(s)	Prof. S. Perlepes
Learning outcomes	At the end of this course the student should be able to: 1. Know the spectrochemical series of ligands and use it to predict the magnetic properties and to interpret electronic spectra of transition metal complexes. 2. Describe the main classes of, discuss the reactivity of and explain the bonding in metallocarbonyls. 3. Differentiate and analyse the various types of distortion from perfect stereochemistry in metal complexes. 4. Discuss the factors that affect the thermodynamic stability of metal complexes. 5. Describe and classify the main mechanisms of inorganic reactions. 6. Know the basic features of the chemistry of 2nd- and 3rd-row transition metals, and lanthanides.
Competences	At the end of the course the student will have further developed the following skills/competences: 1. Ability to demonstrate knowledge and understanding of concepts and principles related to magnetochemistry, electronic structures, stability, molecular structures and reaction mechanisms of transition metal complexes. 2. Ability to demonstrate knowledge and understanding of concepts and principles related to the chemistry of 2nd- and 3rd-row transition elements, and lanthanides. 3. Ability to apply such knowledge and in-depth understanding to solve qualitative problems of an unfamiliar nature. 4. Ability to interact with others on interdisciplinary problems.
Prerequisites	There are no prerequisite courses. It is however recommended that students should have at least a good knowledge of General Chemistry, a basic knowledge of Inorganic Chemistry and an elementary knowledge of Physical Chemistry.
Course contents	1. Inorganic Chemistry through the centuries Historical background and current trends of Inorganic Chemistry. 2. Basic magnetochemistry a) Diamagnetism and paramagnetism of metal complexes, and relation to their electronic structures. b) Low- and high-spin metal complexes. Spin-crossover complexes. c) The effective magnetic moment as a structural tool in transition metal chemistry. 3. Electronic spectra of complexes of first-row transition metal ions a) Spectroscopic terms in octahedral crystal fields. Orgel and Tanabe-Sugano diagrams. Selection rules.

<table>
<tr><td></td><td>b) Interpretation of electronic spectra of octahedral and tetrahedral complexes of the 3dn (n = 2, 3, 7, 8) ions.
4. Metallocarbonyls
a) The 18-electron rule in Organometallic Chemistry.
b) Preparative, reactivity and structural chemistry of metallocarbo-nyls.
c) Chemical bonding in metallocarbonyls.
d) Metal carbonyls in Catalysis.
e) The isolobal approach in Inorganic Chemistry.
5. Distorted stereochemistries in metal complexes
a) Stereochemical aspects.
b) Electronic effects. Jahn-Teller distortions.
6. Thermodynamic stability of metal complexes
a) The Irving-Williams trends.
b) Chelate effect.
c) Hard and soft acids and bases model.
7. Mechanisms of inorganic reactions
a) The trans effect.
b) Substitution reactions in octahedral metal complexes.
c) Mechanisms of redox reactions in metal complexes. Outer- and inner-sphere mechanisms.
8. d-Block metal chemistry: the second and third row metals
a) Introduction.
b) Occurrence, extractions and uses.
c) Physical properties.
d) Periodicity.
e) Aqueous solution species.
f) Coordination complexes.
g) Dinuclear complexes with metal-metal bonds.
h) Polyoxometallates of molybdenum and tungsten.
9. f-Block metal chemistry: the lanthanides
a) Introduction.
b) 4f-Orbital and oxidation states.
c) Atom and ion sizes.
d) Occurrence and separation of the lanthanides.
e) Inorganic compounds and coordination complexes of the lanthanides.</td></tr>
<tr><td>Recommended reading</td><td>1. J.E. Huheey, “Inorganic Chemistry: Prinsiples of Structures and Reactivity”, 3rd Edition, Translation: N. Hadjiliadis, Th. Kabanos, S. Perlepes, Publication ION, St. Parikou O.E., 1993.
2. D.Kessissoglou, P.Akrivos, “Biocoordination Chemistry”, Volume I: Theory, Ziti Publishing Company, 2006.
3. C.E. Housecroft, A.G. Sharpe, “Inorganic Chemistry”, 3rd Edition, Pearson Prentice Hall, 2008.
4. C.E. Housecroft, “The Heavier d-Block Metals: Aspects of Inorganic and Coordination Chemistry”, Oxford Chemistry Primers, Oxford University Press, 1999.</td></tr>
<tr><td>Teaching and learning methods</td><td>Lectures using slides for overhead projector. Problem-solving seminars for the instructive solution of problems. Collaborative problem-solving work by the students working in teams of 3.</td></tr>
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Assessment and grading methods	1. An assay comprising of one synthetic problem solved and presented (15 min, power-point presentation) by groups of 3 students (30% of the final mark, taken into account only when the student secures the minimum mark of 5 in the final written examination). 2. Written examination (70% of the final mark). Greek grading scale: 1 to 10. Minimum passing grade: 5. Grades ≤ 3 correspond to ECTS grade F. Grade 4 corresponds to ECTS grade FX. For the passing grades the following correspondence normally holds: 5 ↔ E, 6 ↔ D, 7 ↔ C, 8 ↔ B and ≥ 9 ↔ A.
Language of instruction	Greek

6th Semester (VI)

Introduction to Spectroscopy of Organic Compounds and to the Chemistry of Biomolecules and of Heterocyclic Compounds

Course title	Introduction to Spectroscopy of Organic Compounds and to the Chemistry of Biomolecules and of Heterocyclic Compounds
Course code	**XO604**
Type of course	Compulsory (Core Chemistry Course)
Level of course	Undergraduate
Year of study	3rd
Semester	6th
ECTS credits	5
Name of lecturer(s)	Prof. Th. Tsegenidis, Assoc. Prof. G. Tsivgoulis, Assist. Prof. C. Athanassopoulos, Assist. Prof. G. Rassias
Learning outcomes	At the end of this course the student should be able to: *Spectroscopy of Organic Compounds:* Use (IR), ^{13}C και^{1}H nuclear magnetic resonance (NMR), separately or in combination with each other, or with additional information from ultraviolet (UV)/visible (Vis) spectroscopy, mass spectrometry (MS), analytical data or descriptive chemistry, to identify structural features or complete structures of “unknown” molecules. Determine a molecular formula either from the accurate mass of a molecular ion or from the isotope peak intensities. Calculate a “double bond equivalent”from a molecular formula and propose possible structural characteristics thereof. *Heterocyclic compounds:* Compare the aromaticity of pyrrole, furan, thiophen and pyridine with that of benzene, showing similarities and differences. Explain the different effect that nitrogen has on the chemistry of pyrrole and pyridine and rationalise their contrasting chemical behaviour. Relate the different chemistry of pyrrole, furan and thiophen to the influence of the heteroatom. *Biomolecules:* Carbohydrates After studying this chapter the student should be able to: 1. Classify carbohydrates as aldoses, ketoses, D or L sugars, monosaccharides or polysaccharides. 2. Draw monosaccharides in the following projections:

	a) Fischer projection. b) Haworth projection. c) Chair conformation. 3. Predict the products of reactions of monosaccharides and disaccharides. 4. Deduce the structure of monosaccharides and disaccharides. <u>Amino Acids, Peptides and Proteins</u> After studying this chapter, the student should be able to: 1. Identify the common amino acids and draw them with correct stereochemistry and dipolar form. 2. Understand the acid-base behavior of amino acids. 3. Synthesize amino acids. 4. Draw the structure of simple peptides. 5. Determine the structure of peptides and proteins. 6. Outline the synthesis of peptides. 7. Draw the structures of reaction products of amino acids and peptides. <u>Lipids</u> After studying this chapter, the student should be able to: 1. Draw the structure of fats, oils, steroids, and other lipids. 2. Determine the structure of a fat. 3. Predict the products of reactions of fats and steroids. 4. Locate the isoprene units in a terpene. 5. Draw the structures and conformations of steroids and other fused-ring systems.
Competences	At the end of the course the student will have further developed the following skills/competences: 1. Ability to demonstrate knowledge and understanding of essential facts, concepts, theories and strategics relating to Spectroscopy, Heterocyclic Chemistry and Chemistry of Natural Products. 2. Ability to adopt and apply methodology to the solution of unfamiliar problems. 3. Study skills needed for continuing professional development. 4. Ability to interact with others on inter or multidisciplinary problems.
Prerequisites	There are no prerequisite courses. However, it is recommended that students should have at least a basic knowledge of General Chemistry, Organic Chemistry and Physics.
Course contents	*Spectroscopy of Organic Compounds* Matter and Electromagnetic Irradiation. UV-VisSpectroscopy (theory– applications). IR and Raman Spectroscopy (theory– applications). MS Spectrometry: a) Description of the principle and the basic parts of a Mass spectrometer as well as the various ionization techniques (EI, CI, MALDI, ES, etc.),b) Fragmentation pathways of the various categories of organic compounds,c) Examples – Applications. Nuclear Magnetic Resonance (NMR) spectroscopy, chemical equivalence, the δ scale, chemical shift. ^{1}HNMR spectra, integration, spin-spin coupling, the n+1 rule. ^{13}CNMR spectroscopy, multiplicity in off-resonance spectra. Combinatorial use of the above spectroscopic/spectrometric techniques for the identification of "unknown" organic compounds. *Heterocyclic compounds* Pyrrole, furan, thiophen, pyridine, aromaticity in monocyclic heterocyclic compounds,

	electrophilic and nucleophilic attack, acid/base properties. *Biomolecules* Aminoacids and peptides: structures of common amino acids, dipolar (zwitterionic) nature, isoelectric points, syntheses of amino acids, the peptide bond, synthesis of peptids, structures of proteins, structure determination of peptids and proteins. Carbohydrates: structures of common carbohydrates, chemical reactions, deduce of structure of monosacharides and disacharides, polysacharides Lipids: structures of the major classes of lipids (fats, phosphatids, terpenoids, steroids, alkaloids), chemical reactions of the triesters of glycerol and of steroids. Nucleic acids: structure of purines and pyrimidines, nucleosides, nucleotides and polynucleotides, synthese of polynucleotides.
Recommended reading	1. L.G. Wade, "Organic Chemistry", 7th edition, Greek translation: D. Komiotis, A. Vronteli, S. Manta, Tziola Technical Publications. 2. J. McMurry, "Organic Chemistry", Volumes I and II, translation in Greek of the original English text, Creta University Press, 1999. 3. A. Valavanidis, "Basic Principles of Molecular Spectroscopy and Applications in Organic Chemistry", Current Topics Publications, 2008. 4. Notes from the teachers.
Teaching and learning methods	Lectures using slides for overhead projector or powerpoint presentations. Problem-solving seminars.
Assessment and grading methods	Written examinations. Greek grading scale: 1 to 10. Minimum passing grade: 5. Grades ≤3 correspond to ECTS grade F. Grade 4 corresponds to ECTS grade FX. For the passing grades, the following correspondence holds: 5 (or 5.5) ⇔ E, 6 (or 6.5) ⇔ D, 7 (or 7.5) ⇔ C, 8 (or 8.5) ⇔ B and ≥9 - 10 ⇔ A
Language of instruction	Greek. Instruction may be given in english in case foreign students attended the course.

Biochemistry-2

Course title	Biochemistry-2
Course code	**XO511**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	3rd
Semester	6th
ECTS credits	10
Name of lecturer(s)	Lectures: Assoc. Prof. A. Aletras, Assist. Prof. S. Skandalis Laboratory: Assoc. Prof. A. Aletras, Assist. Prof. A. Theocharis, Assist. Prof. A. Vlamis, Prof. D. Vynios, Prof. N. Karamanos, Assist. Prof. S. Skandalis
Learning outcomes	At the end of this course the student should be able to: 1. Describe the main biosynthetic pathways of micro- and macrobiomolecules (carbohydrates, fatty acids and other lipids, amino acids and proteins, nucleotides and nucleic acids). 2. Describe the main pathways of micro- and macrobiomolecules (carbohydrates, lipids, amino acids, proteins and nucleic acids) breakdown to meet the energy

	needs of a cell or organism. 3. Know the points where the anabolic and catabolic pathways meet, and how the degradation products of some biomolecules can be used for the synthesis of some others. 4. Know the main steps of the genetic information flow and regulation (DNA replication, transcription-RNA biosynthesis, translation-protein biosynthesis, operon theory). 5. Apply various spectrophotometric methods for the determination of several biomolecules. 6. Isolate and study simple proteins abundant in various natural products. 7. Carry out the kinetic study of an enzyme.
Competences	At the end of the course the student will have further developed the following skills/competences: 1. Ability to demonstrate knowledge and understanding of essential facts, concepts, principles and theories relating to metabolism of micro- and macrobiomolecules (carbohydrates, lipids, proteins, nucleic acids) and genetic information flow and regulation. 2. Ability to apply such knowledge and understanding to the solution of qualitative and quantitative problems of an unfamiliar nature. 3. Ability to adopt and apply methodology to the solution of unfamiliar problems. 4. Study skills needed for continuing professional development. 5. Ability to interact with others on inter or multidisciplinary problems.
Prerequisites	There are no prerequisite courses**.** It is however recommended that students should have at least a basic knowledge of Organic Chemistry and good knowledge of Biochemistry I, particularly of the chapters referring to respiratory chain and oxidative phosphorylation, and citric acid cycle (Krebs cycle).
Course contents	*Theory* 1. Carbohydrates metabolism. Glycolysis, gluconeogenesis, pentose phosphate pathway. Glycogen metabolism. 2. Fatty acids metabolism. The biosynthesis of saturated fatty acids with an even or odd number of carbon atoms. The eukaryotic and prokaryotic fatty acid synthase. Unsaturation of fatty acids, introduction of double bonds. Fatty acids degradation. B-oxidation of saturated and unsaturated fatty acids with an even or odd number of carbon atoms. A-oxidation of fatty acids with brands. 3. The degradation of dietary proteins. The degradation of intracellular proteins, the ubiquitin-proteasome system. Aminotransferases, their function mechanism. Degradation of glucogenic and ketogenic amino acids. The urea cycle. 4. Nitrogenase, nitrogen fixation, synthesis of ammonia. Essential and non-essential amino acids. Biosynthesis of non-essential amino acids. 5. Nucleotides and deoxynucleotides metabolism. Salvage reactions. 6. The biosynthesis of triacyloglycerols, phospholipids, sphingolipids and cholesterol. The lipoproteins. The LDL receptors. The biosynthesis of steroid hormones. 7. DNA replication in prokaryotes and eukaryotes. Prokaryotic and eukaryotic DNA-polymerases. Telomerases and telomeres. Recombination of DNA. DNA mutations and repair mechanisms. 8. RNA synthesis. Prokaryotic and eukaryotic RNA-polymerases. Prokaryotic and eukaryotic promoters. Response elements and transcription factors. Splicing of eukaryotic mRNA. 9. Protein synthesis. The transfer RNA (tRNA). Aminoacyl-tRNA synthetases. The prokaryotic and eukaryotic ribosome. The proteins biosynthesis pathway in prokaryotes and eukaryotes. The wobble hypothesis. 10. Regulation of gene expression. Operon theory.

	Laboratory exercises 1. Spectophotometric methods for protein determination. a) Biuret method. b) Lowry method. c) Bradford method. 2. Preparation of buffer solutions. 3. Titration of glycin. Determination of pK1, pK2 and isoelectric point. 4. Protein isolation. a) Isolation of ovalbumin from eggs. b) Isolation of casein from milk. 5. Physicochemicals properties of proteins. Effect of pH, ionic strength and temperature on protein solubility. Determination of casein isoelectric point. 6. SDS-polyacrylamide gel electrophoresis of proteins. Determination of proteins molecular weight. 7. Immunochemical methods for protein detection and determination. Dot-blot analysis and ELISA, using antibodies against ovalbumin. 8. Enzymes kinetic. Study of acid phosphatase. Effect of temperature and pH on the rate of enzymatic reaction Determination of acid phosphatase Km and Vmax values. 9. Protein denaturation. Effect of high temperature and high urea concentration on enzyme activity. Reverse and non-reverse denaturation. 10. Oxidoreductases. Study of succinate dehydrogenase and glutamate dehydrogenase in liver extract. 11. Glycogen breakdown. Comparative study in liver and muscle extracts.
Recommended reading	1. J.M. Berg, J.L. Tymoczko, L. Stryer, "Biochemistry", Volume I and II, Translation: A. Aletras, Th. Valkana, D. Drainas et al., Creta University Press, 2005. 2. D.L. Nelson, M.M. Cox, "Lehninger Basic Principles of Biochemistry", Volume I, II and III, Ed.: A.G. Papavasileiou, Medicinal Publications P.X. Pasxalidis, 2007 & 2008. 3. C.A. Demopoulos, S. Antonopoulou, "Basic Biochemistry", 2nd revised edition, C.A. Demopoulos, S. Antonopoulou Publications, 2009. 4. J.G. Georgatsos, "Introduction to Biochemistry", 6th Edition, Giahoudi Publications, 2005. 5. C.P. Tsiganos, N. Papageorgakopoulou, S. Anagnostidis, A.J. Aletras, "Laboratory practice in Biochemistry", Publications of University of Patras.
Teaching and learning methods	Lectures using power-point presentations and/or slides for overhead projector. Self-test of each student with multiple-choice questions. Problem-solving seminars for the instructive solution of problems in teams of 25 students.
Assessment and grading methods	1. Writtenexamination of the theory (2/3 of the final mark) 2. Practical and writtenexamination of the laboratory courses (1/3 of the final mark). Both marks should be ≥5. Greek grading scale: 1 to 10. Minimum passing grade: 5. Grades ≤3 correspond to ECTS grade F. Grade 4 corresponds to ECTS grade FX. For the passing grades the following correspondence normally holds: 5 ↔ E, 6 ↔ D, 7 ↔ C, 8 ↔ B and ≥9 ↔ A
Language of instruction	Greek

Food Chemistry

Course title	Food Chemistry

Course code	**XE670**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	3rd
Semester	6th
ECTS credits	5
Name of lecturer(s)	Lectures and laboratory: Prof. M. Kanellaki, Assist. Prof. A. Bekatorou, Assoc. Prof. M. Soupioni
Learning outcomes	At the end of this course the student will: 1. Acquire deeper knowledge on the chemistry and role of the major food constituents (water, carbohydrates, proteins, fats and vitamins). 2. Acquire knowledge relevant to the new trends in food production (novel food with health benefits, probiotics, genetically modified food, functional food etc.) 3. Acquire knowledge relevant to the nutritional value of packaged industrial food (composition, concentration of chemical additives, possibility of contamination with toxic substances).
Competences	At the end of the course the student will have further developed the following skills/competences: 1. Ability to recognize the role and nutritional value of food components and be able to adapt his dairy diet in order to obtain health benefits and face food associated problems (obesity, diabetes, anaemia, etc.) and to inform other people accordingly. 2. Ability to evaluate the nutritional value and safety of industrialized food. 3. Ability to consult food production, processing or analysis enterprises, in which he can also seek employment.
Prerequisites	There are no prerequisite courses. It is however recommended that students should have at least a basic knowledge of Organic Chemistry and Biochemistry.
Course contents	1. Water in food: Free and bound. Water activity (a_w). Significance in food nutrition. 2. Chemistry of carbohydrates: Reactions in food. Carbohydrate containing foods. 3. Chemistry of fruit and other plant foods. 4. Chemistry of cereals and their products. 5. Chemistry of proteins and amino acids: Protein containing foods. Effect of processing on food proteins. 6. Chemistry of meat and its products. 7. Chemistry of milk and dairy products. 8. Chemistry of edible fats and oils. 9. Vitamins: Changes during food processing. Significance to human nutrition. 10. Inorganic constituents: Significance to human nutrition. 11. Food flavours and pigments. 12. Food additives. 13. Toxic substances in food. 14. New trends in food production: • Imitation foods • Genetically modified foods. • Functional foods.
Recommended reading	1. Food Chemistry. Book in progress by the authors. 2. D. Boskou, "Food chemistry", 5th Edition, Gartaganis Publications, 2004. 3. H.-D. Belitz, W. Grosch, P. Schieberle, "Food Chemistry", 3rd Edition, Ed.: S. Rafailidis, Translation: M.D. Papageorgiou, A.I.Varnalis, Tziola Publications, 2007.

	4. O.R.Fennema (editor),"Food Chemistry", 3rd edition, Marcel Dekker Inc., 1996.
Teaching and learning methods	Power point presentations or transparencies.
Assessment and grading methods	Final written course examinations
Language of instruction	Greek. Instruction may be given in English if foreign students attend the course.

Chemical Technology-1 (Principles- Physical and Chemical Processes)

Course title	Chemical Technology-1 (Principles-Physical and Chemical Processes)
Course code	**XE680**
Type of course	Compulsory
Level of course	Undergraduate
Year of study	3rd
Semester	6th
ECTS credits	10
Name of lecturer(s)	Lectures: Prof. I. Kallitsis, Prof. Ch. Kordulis, Assoc. Prof. G. Bokias Laboratory: Prof. I. Kallitsis, Assoc. Prof. G. Bokias, Assist. Prof. Ch. Nteimente, Prof. Ch. Kordulis
Learning outcomes	At the end of this course the student should be able to 1. Apply the Chemical Technology Principles for solving problems related to fluids flow and transfer as well as to the heat transfer taking place in Physical and Chemical Processes. 2. Choosethebestconditionsforcarryingouteffectively physical processes such as distillation, drying, washing and evaporation. 3. Choose the right kind of reactor for performing homogeneous chemical reaction. 4. Calculate the volume and determine the suitable performance conditions of homogeneous chemical reactor for the production of certain quantity of a chemical. 5. Determine the rate equation of homogeneous reactions.
Competences	At the end of the course the student will have further developed the following skills/competences: 1. Ability to demonstrate knowledge and understanding of essential facts, concepts, principles and theories relating to productive performance of physical processes and homogeneous chemical processes. 2. Ability to apply such knowledge and understanding to the solution of qualitative and quantitative problems of an unfamiliar nature. 3. Ability to adopt and apply methodology to the solution of unfamiliar problems. 4. Study skills needed for continuing professional development. 5. Ability to interact with others on inter or multidisciplinary problems.
Prerequisites	There are no prerequisite courses. It is however recommended that students should have at least a basic knowledge of Physical Chemistry.
Course contents	Units and Dimensions. Basic Aspects Mass Balance Energy Balance Fluids Flow Measurement of Fluids Flow Fluids Transfer

	Heat Transfer. Heat Exchangers Distillation (mainly Re-distillation) Humidification and Drying Leaching Evaporation(fundamental aspects) Overview of Chemical Reaction Engineering Interpretation of Batch Reactor Data Introduction to Reactor Design Ideal Reactors for a Single Reaction Design for Single Reactions Design for Parallel Reactions Potpourri of Multiple Reactions Choosing the Right Kind of Reactor
Recommended reading	1. J. Mikrogiannidis, “Fundamental Aspects and Physical Processes of Chemical Technology”, Teaching Books Publishing Organization. 2. J. Mikrogiannidis, “Chemical Technology Problems”, Teaching Books Publishing Organization. 3. Th. Karapantsios, A. Zoumpoulis, K. Matis, P. Mavros, “Elements of Physical Processes”, Tziolas Publications, 2009. 4. O. Levenspiel, “Chemical Reaction Engineering”, Translation: F. Pomonis, K. Matis, et al., Kostarakis Publications, 2004. 5. J. Smith, “Chemical Reaction Engineering”, Tziolas Publications, 1997. 6. P. Mavros, K. Matis, K. Triantafyllides, “Elements of Chemical Processes”, Tziolas Publications, 2009. 7. M. Zoumpoulis, N. Kostoglou, K. Lazarides, “LaboratoryExercises of Chemical Dechnology”, Tziolas Publications, 2009. 8. N. Kalfoglou, J. Mikrogiannides, J. Kallitsis, C. Gravalos, “Exercises of Physical Processes of Chemical Technology”, Publications of University of Patras. 9. Ch. Kordulis, Ch. Fountzoula, K. Goudani, “Laboratory Notes for Chemical Processes”, Publications of University of Patras.
Teaching and learning methods	Power-point presentations. Problem-solving seminars. Laboratory exercises performed by the students working in teams of four.
Assessment and grading methods	1. Two written examinations (one in the middle of the semester and one at the end), which substitute the final written one when the student secures the minimum mark of 7.0 in each one of them. 2. Problems given during the corresponding seminars solved by each student (20% addition of the mark of final written examination, taken into account only when the student secures the minimum mark of 5 in the final written examination). 3. Oral and /or written examination during each laboratory exercise (20% of the final mark, taken into account only when the student secures the minimum mark of 5 in the final written examination). 4. Writtenexamination (80% of the final mark). Greek grading scale: 1 to 10. Minimum passing grade: 5. Grades ≤3 correspond to ECTS grade F. Grade 4 corresponds to ECTS grade FX. For the passing grades the following correspondence normally holds: 5 ↔ E, 6 ↔ D, 7 ↔ C, 8 ↔ B and ≥9 ↔ A
Language of instruction	Greek

Semi-optional Courses
(two courses/10 ECTS credits)

Materials Chemistry and Technology (Polymers, Nanomaterials, Colloids, Catalysts)

Course title	Materials Chemistry and Technology (Polymers, Nanomaterials, Colloids, Catalysts)
Course code	**XE781**
Type of course	Semi optional
Level of course	Undergraduate
Year of study	4th
Semester	7th
ECTS credits	5
Name of lecturer(s)	Lectures: Prof. I. Kallitsis, Prof. Ch. Kordulis Laboratory: Prof. I. Kallitsis, Prof. Ch. Kordulis, Assoc. Prof G. Bokias, Assist. Prof. Ch. Deimede
Learning outcomes	At the end of this course the student should be able to 1. Describe that synthesis and characterization of polymeric materials. 2. Understand the physicochemical principles in polymers. 3. Describe the properties of polymers in solid state. 4. Describe the structure of porous materials at various levels. 5. Describe the physicochemical characteristics of nanostructured carbon materials and other nanomaterials. 6. Describe the structureand texture of supported catalysts.
Competences	At the end of the course the student will have further developed the following skills/competences: 1. Ability to demonstrate knowledge and understanding of essential facts, concepts, principles and theories relating to structure and properties of materials. 2. Ability to apply such knowledge and understanding to the solution of qualitative and quantitative problems of an unfamiliar nature. 3. Ability to adopt and apply methodology to the solution of unfamiliar problems. 4. Study skills needed for continuing professional development. 5. Ability to interact with others on inter or multidisciplinary problems.
Prerequisites	There are no prerequisite courses. It is however recommended that students should have at least a basic knowledge of Inorganic, Organic and Physical Chemistry as well as Instrumental Analysis.
Course contents	*Polymers* ▪ Introduction-Applications. ▪ Polymer synthesis. ▪ MW characterization. ▪ Physical chemistry of polymer solutions. ▪ Amorphous polymers. ▪ Mechanical properties of polymers. *Nanocomposite materials*

	▪ Fullerenes, Carbon Nanotubes. ▪ Other Carbon Nanostructures ▪ Metal Organic Frameworks. ▪ Dendrimers. ▪ Nanoparticles. *Porous Materials* ▪ Non porous nanocrystals. ▪ Porous nanocrystals-Zeolites. ▪ Ordered Mesoporous amorphous particles (MCM, SBA, etc.). ▪ Foams. ▪ Intraparticle porosity. ▪ Nanoparticles agrigation–Development of Interparticle porosity. ▪ Shaped particles. ▪ Catalytic nanoparticles dispersed on the surface of porous materials.
Recommended reading	1. D.D. Dodos, "Synthetic Macromolecules", Kostarakis Publications, 2002. 2. G.P. Karagiannidis, E.D. Sideridou, "Chemistry of Polymers", Zitis Publications, 2006. 3. J.M.G. Cowie, "Polymers: Chemistry & Physics of Modern Materials", 2nd Edition, Chapman and Hall, 1991. 4. J.G. Odian, "Principles of Polymerization" John Wiley Inc., 1991. 5. R. Seymour, G. Garraher Jr., "Polymer Chemistry", Marcel-Dekker, Inc., 1996. 6. Y. Gogotsi, "Laboratory exercises in chemistry and technology of materials", Taylor & Francis, 2006.
Teaching and learning methods	Power-point presentations. Problem-solving seminars. Laboratory exercises performed by the students working in teams of four.
Assessment and grading methods	1. Oral and/or written examination during each laboratory exercise (20% of the final mark, taken into account only when the student secures the minimum mark of 5 in the final written examination). 2. Written examination (80% of the final mark). Greek grading scale: 1 to 10. Minimum passing grade: 5. Grades ≤3 correspond to ECTS grade F. Grade 4 corresponds to ECTS grade FX. For the passing grades the following correspondence normally holds: 5 ↔ E, 6 ↔ D, 7 ↔ C, 8 ↔ B and ≥9 ↔ A
Language of instruction	Greek

Environmental Chemistry

Course title	Environmental Chemistry
Course code	**XE790**
Type of course	Semi optional
Level of course	Undergraduate
Year of study	4th
Semester	7th
ECTS credits	5

Name of lecturer(s)	Lectures and Laboratory: Assist. Prof. H. Karapanagioti, Assoc. Prof. E. Papaefthymiou
Learning outcomes	At the end of this course the student will know: 1. The structure and division of the atmosphere. Units of concentration of air pollutants and their conversion. Formation and destruction of Stratospheric Ozone, with natural and anthropogenic emissions. Formation of ozone hole in the stratosphere of Antarctica. 2. Planetary Climatic Change. Green house effect. Factors that affect the global warming action of global warming gases. Effects of global warming 3. Air Quality Standards of regulated pollutants: NOx, CO, SO_2, ozone and particulate matter PM10 and PM2.5. Methods of their determination in the atmosphere. 4. Tropospheric ozone. Formation. Destruction. The role of NOx and VOC. Emissions of stationary and mobile sources. Mechanisms of reaction of alkanes-olefins-aromatic hydrocarbons with hydroxyl and nitrate radicals as well ozone. 5. Acid Rain. Definition of acid rain. Dissolution of carbon dioxide in rain water and pH of pure rain. Emissions of NOx and SO_2. Mechanism of transformation of NOx and SO2 to nitric and sulfuric acid in the gaseous and aqueous phase. The role of oxidants of the atmosphere. 6. Explain in detail the processes taking place at each stage (what is the name of the process, what is the type, what is removed and how) of the flow chart of a typical treatment plant a) desalination for drinking water, b) surface water for drinking water c) groundwater for drinking water, and d) for municipal wastewater 7. Recognize the differences in wastewater characteristics and the treatment methods required for each type of wastewater. 8. Compare the available analytical methods for measuring wastewater COD and BOD. 9. Describe pollution phenomena for the various water bodies.
Competences	At the end of the course the student will have further developed the following skills/competences 1. Ability to demonstrate knowledge and understanding of essential facts, concepts, principles and theories relating to Air pollution. 2. Ability to write and present proposals for his research activities. 3. Ability to compare different methodologies for measuring or calculating different parameters. 4. Ability to interact with others on chemical or interdisciplinary problems. 5. Ability to observe the environment and explain everyday phenomena by using his knowledge. 6. Ability to consider the existence of regulations 7. Realization that alternative ways of analysis exist (e.g. using microbes as in the case of BOD measurements)
Prerequisites	There are no prerequisite courses. It is however recommended that students should have at least a basic knowledge of General and Inorganic Chemistry, Organic Chemistry, Analytical Chemistry, Physical chemistry, English and computer.
Course contents	1. Structure of the Atmosphere. Its chemical composition in troposphere and stratosphere. Formation of the Earth;s atmosphere. Division in troposphere and stratosphere. Units of concentration of air pollutants. 2. Stratospheric ozone. Formation and destruction of stratospheric ozone. Chapman mechanism. Destruction of stratospheric ozone from man made emissions. Chlorofluorocarbons, Halogenated hydrocarbons. Ozone hole in Antarctica. 3. Planetary climate change. Energy balance. Absorption of outgoing radiation by global warming gases. Factor that determine the action of global warming gases. Sources of emissions of carbon dioxide, methane, nitrous oxide and chlorofluorocarbons. Scenarios of climate change. Consequences. 4. Tropospheric Ozone. Photochemical air pollution. Precursors’ Emissions in urban

	centers. Stationary and mobile sources of NOx and VOC. Mechanisms of transformation of alkanes, olefins and aromatic hydrocarbons under atmospheric conditions and formation of ozone. Hydroxyl and nitrate radicals. Control strategies of photochemical ozone formation. 5. Acid rain. Acid rain in US, Scandinavia and Greece. Emissions of NO_x and SO_2 from stationary sources. Energy production, industry. Mechanisms of transformation of NO_x and SO_2 to nitric and sulfuric acids in the gaseous and aqueous phase. Nuetralization of atmosphere; acidity. 6. Elements of Meteorology. Dry adiabatic lapse rate. Boundary layer. Horizontal and vertical dispersion. Mechanisms of formation of temperature inversions. Synoptic and local winds. 7. Introduction to water pollution, water distribution, historical phenomena of pollution, new problems, water pollution (pollutants, sources, and effects), wastewater with organic loadings, nutrients, natural attenuation. 8. Basic hydrology, hydrological cycle, groundwater, surface and submarine estuaries, saltwater intrusion, water pollution originating from land pollution. 9. Water characteristics, alkalinity, hardness, Drinking water treatment, disinfection (regulations and history, chlorination, chlorine chemistry, ozone, fluorination) coagulation (particles, mechanisms of stability and instability of particles coagulants, removal of color from water), chemical sedimentation (solubility product, hardness removal, occurrence and removal of iron and manganese from groundwater), removal of taste and odor, reverse osmosis. 10. Municipal and industrial wastewater characteristics, first, second and third grade treatment, sludge treatment. 11. Laboratory exercises: COD and BOD measurements. 12. Field trips to: desalination plant for drinking water, surface water treatment plant for drinking water, wastewater biological treatment plant, industrial wastewater treatment plant.
Recommended reading	1. S.D. Glavas, “Introduction to Atmospheric Chemistry”, Publications of University of Patras, 2000. 2. S.P. Tsonis, “Water Treatment”, Papasotiriou Publications, 2003. 3. S.P. Tsonis, “Waste Treatment”, Papasotiriou Publications, 2004.
Teaching and learning methods	Lectures using power-point presentations (400-500 slides) that are then available at the educational platform eclass.upatras.gr, problem-solving seminars for the instructive solution of problems without and with the use of software in the multimedia laboratory room, laboratory exercises, field trips, a collaborative laboratory semester project for students working in teams of 2-4.
Assessment and grading methods	The grade percentage is distributed as follows: 1. Laboratory and field trip reports (20% of the final mark, taken into account only when the student secures the minimum mark of 5 in the final written examination). 2. Semester project proposal and report (30% of the final mark, taken into account only when the student secures the minimum mark of 5 in the final written examination). 3. Written examination (50% of the final mark). Greek grading scale: 1 to 10. Minimum passing grade: 5. Grades ≤3 correspond to ECTS grade F. Grade 4 corresponds to ECTS grade FX. For the passing grades the following correspondence normally holds: 5 ↔ E, 6 ↔ D, 7 ↔ C, 8 ↔ B and ≥9 ↔ A
Language of instruction	Greek. Instruction may be given in English if foreign students attend the course.

Principles and Applications of Nuclear Chemistry

Course title	Principles and Applications of Nuclear Chemistry
Course code	**XA741**
Type of course	Semi Optional
Level of course	Undergraduate
Year of study	4th
Semester	7th
ECTS credits	5
Name of lecturer(s)	Lectures and Laboratory: Assoc. Prof. H. Papaefthymiou, Assist. Prof. V. Symeopoulos, Assoc. Prof. M. Soupioni
Learning outcomes	At the end of this course the student should be able to 1. Know the basic concepts of radiochemistry. 2. Have a concise knowledge of the basic applications of radioactivity in chemistry. 3. Know the basic principles of nuclear instrumentation. 4. Manipulate radioactive substances safely and carry out measurements by using Geiger-Muller counter and scintillation detector. 5. Understand how basic determinations related to radioanalytical techniques are carried out. 6. Knowhow matter tobe shielded and protected from ionizing radiation. 7. Know the process of monitoring exposure to radiation and the units used to measure radiation effects.
Competences	At the end of the course the student will have further developed the following skills/competences: 1. Ability to demonstrate knowledge and understanding of essential concepts and principles related to radiochemistryand its applications. 2. Ability to apply such knowledge to the solution of chemical problems using radionuclides. 3. Ability to apply such specific knowledge in as many other fields. 4. Ability to get more specific knowledge for professional development.
Prerequisites	There are no prerequisite courses. It is however recommended that students should have at least a basic knowledge of General Chemistry.
Course contents	*1. Introduction to Radiochemistry.* Discovery of radioactivity, forces in matter and subatomic particles, nuclides and natural decay series. *2. Nuclear properties.* Description of nucleus, mass and energy relationships. *3. Types of radioactive decay.* α-, β- and γ-decay. *4. Rates of nuclear decay.* Rates of radioactive decay, units of radioactivity. *5. Nuclear reactions.* Types, energetics, cross sections of nuclear reactions, fission, fusion. *6. Activation analysis.* Overview, advantages and disantvantages, sources used,kinds of interferences, qualitative and quantitative determination. Types of Activation Analysis (TNAA, ENAA, RNAA) and their applications. *7. Radiotracer Methods.* Choice and production of radiotracers. Essential knowledge of Isotope Dilution Analysis. *8. Ion Beam Analysis.* Brief description of Rutherford Backscattering and Mossbauer Spectroscopy. *9. Principles of Nuclear Reactors.* Multiplication factor, four factor formula, reactor core, critical mass, reactor coolant, moderator, enriched fuels, poisons, excess reactivity, temperature coefficient of reactivity, delay neutrons, breeder reactor. *10. Interactions of radiation with matter.* Modes of interactions, Alfa-particle, beta-particle, gamma-ray and neutron interactions, Physical effects of radiation on matter.

	11. Health Physics. Radiation quantities and units, Biological Effects of Radiation, Sources of Radiation exposure, Radiation Protection and control.
Recommended reading	1. W.D. Ehmann, D.E. Vance, "Radiochemistry and Nuclear Methods of Analysis", Translation: P. Dimotakis, P. Misailidis, E. Papaeftymiou, et al., Macedonian Publications, 1998. 2. K.H. Lieser, "Nuclear Chemistry and Radiochemistry: Fundamentals and Applications", VCH Publishers, 1997. 3. G.R. Choppin, J. Rydberg, "Nuclear Chemistry-Theory and Applications", 1st Edition, Pergamon Press, 1980. 4. A. Mozumber, "Fundamentals of Radiation Chemistry", Academic Press, 1999.
Teaching and learning methods	Lectures using power-point presentations and multimedia. Problem-solving work by the students.
Assessment and grading methods	1. Written examination (70% of the final mark). 2 Laboratory exercises (30% of the total mark, taken into account only when the student secures the minimum mark of 5 in the final written examination). Greek grading scale: 1 to 10. Minimum passing grade: 5. Grades ≤3 correspond to ECTS grade F. Grade 4 corresponds to ECTS grade FX. For the passing grades the following correspondence normally holds: 5 ↔ E, 6 ↔ D, 7 ↔ C, 8 ↔ B and ≥9 ↔ A
Language of instruction	Greek

Optional (Elective) Chemistry Courses (one or two courses/10 ECTS credits)

NMR Spectroscopy, Molecular Modeling and Design

Course title	NMR Spectroscopy, Molecular Modeling and Design
Course code	**XO705**
Type of course	Optional (Chemistry course)
Level of course	Undergraduate
Year of study	4th
Semester	7th
ECTS credits	5
Name of lecturer(s)	Assoc. Prof. Th. Tselios, Assoc. Prof. G. Tsivgoulis, Assoc. Prof. C. Athanassopoulos
Learning outcomes	At the end of this course the student should be able to: 1. Present the 2D NMR techniques, ^{1}H-^{1}H/^{13}C/^{15}N, and their importance on identification and conformational analysis of molecules. 2. Analyze and Interpret homo- & hetero- nuclear 2D NMR spectra. 3. Present methodsforConformational Analysis of molecules. 4. Select and apply the most appropriate methods for conformational analysis of molecules. 5. Select and apply the most appropriate Energy Minimization Methods for conformational analysis of molecules.
Competences	At the end of the course the student will have further develope the following skills/competences

	1. Ability to demonstrate knowledge and understanding of essential facts, concepts, principles and theories related to 2D NMR, ^{1}H-$^{1}H/^{13}C/^{15}N$, Molecular Modeling and Molecular Design and to perform assignment of signal resonances in 2D NMR spectra. 2. Ability to apply such knowledge and understanding to the solution of NMR, Molecular Modelling and Molecular Design issues. 3. 2D NMR, Molecular Modelling and Molecular Design skills needed for continuing professional development. 4. Ability to interact with others on inter or multidisciplinary 2D NMR, Molecular Modelling and Molecular Design problems.
Prerequisites	There are no prerequisite courses. It is however recommended that students should have at least a basic knowledge of NMR and Organic Chemistry.
Course contents	*1. Principles of NMR and Organology.* Fourier Transform (FT) and Continuous Wave (CW) NMR, Organology data, T1 and T2 relaxation time. Inversion Recovery experiment, chemical shift ^{13}C, "Spins Echo" method, APT και DEPT techniques. Examples. *2. 2D NMR.* Principles, Hetero nuclei coupling, Hetero nuclei 1D NMR, 2D spectrum theory, Types of 2D spectrums: COSY, TOCSY, RELAY, COLOC, INADEQUATE, Examples. Analysis of 2D homo- & hetero- nuclear NMR spectra. Examples. Evaluation of homo- & hetero- nuclear 2D NMR. *3. Nuclear Overhauser Effect (NOE).* Principles, Effect explanation, NOE and nuclei distance, NOE and rotation time Tc (Correlation Time). *4. Molecular Modeling.* Basic Principles, Molecular Graphics, Conformations of Proteins-Peptides, Molecular Surfaces, Potential Energy Surfaces, Computer Simulation Methods-MolecularMechanics, Energy Minimization and Related Methods for Exploring the Energy Surface. Examples and Applications. *5. Conformational Analysis.* Monte Carlo method, Molecular Dynamics-Constraint Dynamics method, Grid Scan method, Boltzmann Jump method. Examples and Applications.
Recommended reading	1. T. Mavromoustakos, J. Matsoukas, "NMR: Principles and Applications in Medicine, Pharmaceutical Chemistry, Biochemistry, Food Chemistry", 1st Edition, G.V. Parisanos, Publications, 2006. 2. T. Mavromoustakos, P. Zoumpoulakis, "Molecular Modeling: Applications in Organic and Pharmaceutical Chemistry", 1st Edition, G. Parisanos Publications, 2008. 3. J. Matsoukas, "Modern methods of spectroscopy", Publications of University of Patras. 4. R.M. Silverstein, F.X. Webster, D.J. Kiemle, "Spectrometric Identification of Organic Compounds", 7th Edition, John Wiley & Sons, 2005. 5. A.R. Leach, "Molecular Modelling: Principles and Applications», 2nd Edition, Prentice Hall, 2001. 6. G.L. Patrick, "An introduction to Medicinal Chemistry", 3rd Edition, Oxford University Press, 2005.
Teaching and learning methods	Lectures using slides for overhead projector and/or power-point presentations and appropriate software (Molecular Conceptor II). Problem-solving seminars for 2D NMR and Molecular Modeling-Design. Collaborative problem-solving work by the students working in teams of two.
Assessment and grading methods	1. An assay comprising off a presentation of a subject referred to 2D NMR and Molecular Modeling-Design (groups of two students, 50% of the final mark). 2 Written examination (50% of the final mark). Greek grading scale: 1 to 10. Minimum passing grade: 5. Grades ≤3 correspond to ECTS grade F. Grade 4 corresponds to ECTS grade FX. For the passing grades the following correspondence normally holds:

	5 ↔ E, 6 ↔ D, 7 ↔ C, 8 ↔ B and ≥9 ↔ A
Language of instruction	Greek. Instruction may be given in English if foreign students attend the course.

Synthetic Organic Chemistry

Course title	Synthetic Organic Chemistry
Course code	**XO706**
Type of course	Optional (Chemistry course)
Level of course	Undergraduate
Year of study	4th
Semester	7th
ECTS credits	5
Name of lecturer(s)	Prof. D. Papaioannou, Assoc. Prof. C. Athanassopoulos
Learning outcomes	At the end of this course the student should be able to: 1. Present the most important methods for the preparation of open chain and cyclic mono- and poly-functional compounds (reactions involving interconversion of functional groups and introduction and removal of protecting groups, formation of new C-C and C-heteroatom bonds, and appropriate oxidation or reduction agents/conditions). 2. Apply the principles of retro synthetic analysis to identify the most appropriate disconnections for use in the synthesis of organic molecules of moderate complexity. 3. Evaluate chemical methods for the creation of asymmetric centres and their possible stereo-chemical outcomes in multi-step synthesis. 4. Apply antithetic analysis to propose synthesis of well-known natural products and current drugs. 5. Present the most important methods of asymmetric synthesis and of other current methods of synthesis including synthesis on solid supports, combinatorial synthesis and syntheses involving multi-component reactions and tandem reactions 6. Apply the principles and the methods of asymmetric synthesis to propose syntheses of chiral organic molecules of moderate complexity.
Competences	At the end of the course the student will have further developed the following skills/competences: 1. Ability to demonstrate knowledge and understanding of essential facts, concepts, theories and strategic relating to Synthetic Organic Chemistry chemistry 2. Ability to apply such knowledge and understanding to the solution of synthetic problems of an unfamiliar nature. 3. Ability to adopt and apply methodology to the solution of unfamiliar problems. 4. Study skills needed for continuing professional development. 5. Ability to interact with others on inter or multidisciplinary problems.
Prerequisites	There are no prerequisite courses. It is, however, recommended that students should have at least a basic knowledge of Organic Chemistry.
Course contents	1. *Preparation and Interconversion of Functional Groups* Syntheses and Reactions of the foolloeing functional groups: Alkanes, Alkenes, Alkynes, Alcohols, Alkyl halides, Ethers-Epoxides, Aldehydes-Ketones, Carboxylic acids-Anhydrides-Acyl chlorides-Esters-Amides-Nitriles, Amines, Aromatic compounds. 2. *Preparation of Functional Groups with C-C Bond Formation* Nucleophilic Carbon Compounds, Electrophilic Carbon Compounds, Syntheses of

	compounds with one fanctional group (Alkanes, Alkenes, Alkynes, Alcohols, Aldehydes-Ketones,Carboxylic acids, Nitriles), Syntheses of compounds with two functional groups at positions 1,2-, 1,3-, 1,4-, 1,5- and 1,6- 3. *Methods for the Synthesis of Cyclic Compounds* Typesofring-forming reactions, Factors affecting ring- formation, Methods for the formation of macrocyclic compounds, Methods for the formation of 3-6 membered carbocyclic rings 4. *Retrosynthetic (or Antithetic) Analysis* Introduction (Transforms or retro-reactions, Target-molecule, Synthons, Equivalent reagents or reactants, Retrons, Types of Transforms), Antithetic Disconnections (disconnections of one and two functional groups at positions 1,2-, 1,3- and 1,5-, Non-obvious disconnections of functional groups at positions 1,2-, 1,4- and 1,6-, Disconnection of the pericyclic type, Disconnections of heteroatoms and heterocycles, Disconnections of small rings), Strategy in Synthesis, Applications of the Retrosynthetic Analysis to the synthesis of natural products. 5. *Asymmetric Synthesis* Chemical [with the use (α) chiral templates, (β) asymmetric induction] and biological methods of a symmetric synthesis, Applications to the synthesis of natural products and drugs. 6. *Current Trends in Synthesis* Solid-phase Synthesis, Combinatorial Chemistry, Multi-component Reactions, Tandem Reactions, Selection of other synthetic methodologies from the current Organic Chemistry research literature.
Recommended reading	1. D. Papaioannou, “Synthetic Organic Chemistry”, Papazisis Publications, 1995. 2. J.R. Hanson, “OrganicSyntheticMethods” Tutorial Chemistry Texts No. 12, Royal Society of Chemistry, 2002. 3. J.-H. Fuhrhop and G. Li, “Organic Synthesis: Concepts and Methods”, 3rd revised Edition, Wiley-VCH GmBH, 2003. 4. M.B. Smith, “OrganicSynthesis”, 2nd Edition, McGraw-Hill, New York, 1994. 5. P. Wyatt, S. Warren, “OrganicSynthesis: Strategy and Control”, John Wiley & Sons, 2007. 6. Review papers on current trends in synthesis from the Organic Chemistry Literature.
Teaching and learning methods	Lectures using slides for overhead projector or powerpoint presentations. Problem-solving seminars for the instructive solution of synthetic problems. Collaborative problem-solving work by the students working in teams of two.
Assessment and grading methods	1. Optionally, three assays with synthetic problems solved by groups of two students (the 30% of the mean mark for the three assays is added to the final exams mark, taken however into account only when the student secures the minimum mark of 4 in the final written examination) 2. Written examination (final mark, unless the student participated in the preparation of the afore mentioned all three assays during the semester, in which case the final mark is calculated as described above). Greek grading scale: 1 to 10. Minimum passing grade: 5. Grades ≤3 correspond to ECTS grade F. Grade 4 corresponds to ECTS grade FX. For the passing grades, the following correspondence holds: 5 (or 5.5) ⇔ E, 6 (or 6.5) ⇔ D, 7 (or 7.5) ⇔ C, 8 (or 8.5) ⇔ B and ≥9 - 10 ⇔ A
Language of instruction	Greek. Instruction may be given in English in case foreign students attending the course.

Food Chemistry and Technology-Oenology I

Course title	Food Chemistry and Technology-Oenology I
Course code	**XE771**
Type of course	Optional (Chemistry course)
Level of course	Undergraduate
Year of study	4th
Semester	7th
ECTS credits	10
Name of lecturer(s)	Lectures and Laboratory: Prof. M. Kanellaki, Assist. Prof. A. Bekatorou
Learning outcomes	At the end of this course the student will attain knowledge on: 1. The chemistry, nutritional value, microbiology and methods of production of carbohydrate, protein and fat containing foods, juices, alcoholic beverages, and dairy products at industrial, trade or household scale. 2. The industrial practices and new trends for the improvement of quality and production processes of foods, as well as for the production of novel foods with health benefits. 3. The significance of fermentation technology on food production and the connection of biotechnology with the food industry. 4. The application of analytical methods for the determination of food composition.
Competences	At the end of the course the student will have further developed the following skills/competences: 1. Practical skills on the separation and analysis of food components using classical and instrumental analytical techniques. 2. Ability to recognize the role and nutritional value of food components and be able to adapt his dairy diet in order to obtain health benefits and face food associated problems (obesity, diabetes, anaemia, etc.) and to inform other people accordingly. 3. Ability to evaluate the nutritional value and safety of industrialized food. 4. Knowledge of winemaking practices (dry, sweet, semi-sweet, red and white winemaking). 5. Ability to evaluate the effect of processing on food composition and quality. 6. Skills to seek employment in food industries, small scale enterprises and laboratories, which comprise the biggest part of the Greek market. 7. Ability to assess knowledge for the selection of suitable products/technologies for the development of new enterprises for production, processing or analysis of food. 8. Ability to consult food production, processing or analysis enterprises.
Prerequisites	There are no prerequisite courses. It is however recommended that students should have at least a basic knowledge of Organic Chemistry, Biochemistry and Chemical Technology.
Course contents	*Lectures*: 1. *Sugars*: Production of syrups (raisin syrup, date syrup). Sugar production-molasses. Flour-pasta-bread. Sweeteners. Starch and glucose industry. Honey. 2. *Oenology*: Must composition. Must adjustments. Alcoholic fermentation. White dry wine making. Red dry wine making. Sweet wine making (*misteli*). Sparkling wines. *Retsina-Stafiditis* wines. *Mavrodafni* wine. Thermovinification. Wine composition. Volatile by-products of alcoholic fermentation. Ageing-esterification. Wine defects and spoilage-haze formation. Clarification and finishing. Decanting. Cold stabilization. Filtration/filters. Centrifugation. Anhydrous sulphite in wine making. Pasteurization. Bottling. Oenology mechanics: Grape crushing/crushers. Destemming/destemmers. Presses. Pumps. Types of fermentation bioreactors (fermentation tanks). Must recirculation during fermentation. Wine fillers cappers, packers. Bottle washers.

	Installation of bottling unit. Wine testing: colour and appearance, aroma and taste, sweet, sour or astringent constituents. Sulphited musts. Vinegar production. Wine and other grape products in human nutrition. Alcoholic beverages: Distillates. *Tsipouro*, *tsikoudia*, *ouzo*, brandy, whiskey, vodka. Potable alcohol from raisins, molasses, cereals and potatoes. Fast alcoholic fermentations using *Saccharomyces cerevisiae* and *Zymomonas mobilis.* Bioreactors. Alcoholic fermentation parameters. Refineries. Liquors. 3. *Brewing*. Malting. Brewing. Beer maturation. By-products. 4. *Citrus juice industry*. Raw material. Juice extraction. Juice quality and factors affecting it. Thermal treatment of juice. Juice concentration. Essential oils. 5. *Fats and oils*. Degradation of fats and oils. Raw material and product treatments (purification, decolourisation, deodorization, hydrogenation). 6. *Meat technology*. Composition. Microbiology. Canning. Meat products. 7. *Milk technology*. Composition. Microbiology. Treatments (filtration, cooling, pasteurization, concentration, homogenization, skimming). 8. *Dairy products*. *Laboratory exercises*: 1. Analytical presentation of all exercises that will be performed in the laboratory – Assessment. 2. Analysis of flour. (a) Gluten determination, (b) ash determination, (c) detection of oxidants. 3. Analysis of edible oils. Determination of: (a) saponification number, (b) acidity, (c) iodine number, (d) colour reactions, (e) chemical antioxidants and paraffin oil in olive oil by thin layer chromatography. 4. Analysis of milk. Determination of: (a) proteins by the Kjeldahl method, (b) fat by the Gerber method, (c) specific weight. 5. Analysis of total fat in olive pit, cocoa and dried fruit, by Soxhlet extraction. 6. Analysis of sugars in honey. Determination of: (a) reducing sugars, (b) total sugars, and (c) sucrose. 7. Analysis of sugars in honey. Determination of glucose and fructose. Detection of adulteration by synthetic invert sugar and concentrated starch hydrolysate. 8. Oenology. Yeasts. (a) Preparation of liquid culture. (b) Preparation of solid culture. (c) Preparation of liquid culture in grape must for the promotion of wine fermentation. (d) Determination of yeast concentration in fermenting must. 9. Oenology. Examination of grape must and alcoholic fermentation. (a) determination of ^{o}Be density, (b) determination of total acidity, (c) must adjustments, (d) alcoholic fermentation for white wine making, (e) alcoholic fermentation for red sweet wine making, (f) production of *misteli* wine, (g) fast alcoholic fermentation by addition of yeast, (h) fermentation kinetics, (i) determination of cell concentrations, (j) microscopic examination of yeasts (observation of healthy yeast cells, dead cells, bacteria), (k) examination of yeast cells before fermentation. 10. Oenology. Chemical analysis of wines: (a) alcoholic degree, (b) total acidity, (c) volatile acidity, (d) sulphite determination (free, bonded and total). 11. Oenology. Post fermentation treatments for red and white wine making. (a) 48-hour monitoring of fermentation: macroscopically and microscopically. Promotion of stuck fermentations by addition of yeast. (b) Cease of fermentation by addition of alcohol for sweet wine making. (c) Confirmation of the end of fermentation. Decanting. Clarification by racking. Fining by egg-white albumin. Addition of sulphur dioxide. Cold-stabilisation. Filtration. 12. Analysis of olive oil and seed oils by gas chromatography. 13. Wine testing. Sensory evaluation of wine aroma and taste.
Recommended reading	1. A.A. Koutinas, M. Kanellaki,"Food Chemistry and Technology", Publication of University of Patras, 2010.

	2. E. Voudouris, M. Kontominas, "Introduction to Food Chemistry", OEDB Publications, 2006. 3. H.-D. Belitz, W. Grosch, P. Schieberle, "Food Chemistry", 3rdrevised edition, Ed.: S. Rafailidis, Translation: M.D. Papageorgiou, A.I. Varnalis, Tziolas Publication, 2007. 4. N. Potter, J. H. Hotchkiss, "Food Science", 5th Edition, Chapman & Hall, 1995. 5. O.R.Fennema,"Food Chemistry", 3rd Edition, Marcel Dekker Inc., 1996. 6. R.S. Jackson "Wine Science: Principles and Applications, 3rd Edition, Elsevier, 2008.
Teaching and learning methods	1. Power point presentations or transparencies. Theoretical presentation of laboratory exercises and solution of example calculations. 2. Laboratory exercises by teams of 2-3 students. 3. Visits to food industries/enterprises.
Assessment and grading methods	1. Laboratory exercises (account for 40% of the final mark). Average of: (a) oral and written test examination marks after the end of each exercise, (b) final written laboratory examination mark, and (c) final oral examination mark on Oenology exercises. 2. Final written course examination mark (accounts for 60% of the final mark).
Language of instruction	Greek. Instruction may be given in English if foreign students attend the course.

Chemistry of Organometalic Compounds and Mechanism in Inorganic Reactions

Course title	Chemistry of Organometalic Compounds and Mechanism in Inorganic Reactions
Course code	**XA725**
Type of course	Optional (Chemistry course)
Level of course	Undergraduate
Year of study	4th
Semester	7th
ECTS credits	5
Name of lecturer(s)	Prof. S. Perlepes, Prof. N. Klouras
Learning outcomes	At the end of this course the student should be able to: 1. Decide whether a compound is organometallic or not. 2. Write the IUPAC name given the structural formula of an organometallic compound and vice versa. 3. Count electrons and charges of ligands by the ionic or by the covalent (or radical) convention. 4. Choose the proper solvent for an organometallic reaction. 5. Describe main group organometallic compounds and their properties, preparation methods and applications as well. 6. Explain and apply the 18-electron rule to transition element organometallic compounds. 7. Explain the bonding in metal carbonyls and provide evidence for synergetic bonding. 8. Discuss the bonding types of carbonyl ligands. 9. Formulate synthetic methods, important reactions and properties of transition metal carbonyls. 10. Recognize the role of phosphines as ligands. 11. Describe complexes with alkyl, alkene, and alkyne Ligands.

	12. Identify the sandwich compounds, describe a method of preparation, their properties and uses as well. 13. Name some important applications of organometallic compounds in industrial catalysis.
Competences	At the end of the course the student will have further developed the following skills/competences: 1. Ability to give several examples illustrating how organometallic molecules are strikingly different from those encountered in classical Inorganic and Organic Chemistry. 2. Skills of applying the 18-electron rule in order to predict constitution and stability of organometallic compounds and to design new compounds. 3. Skills in using Grignard and organolithium compounds in synthetic organic chemistry. 4. Competence to provide examples for the synthesis of silicones, polymers of great commercial importance, according to the Rochow process. 5. Ability in using important terms of Organometallic Chemistry like hapticity, back-bonding, cluster compounds, hydroboration, ring whizzing, and fluxionality. 6. Ability to explain the various applications of ferrocene and its derivatives. 7. Ability to explain the mode of catalytic action of some transition-metal complexes in industrial applications.
Prerequisites	General Chemistry, Inorganic Chemistry, Organic Chemistry
Course contents	1. Naming Organometallic Compounds 2. Counting Electrons 3. Solvents for Organometallic Chemistry 4. Main Group Organometallic Compounds – Organometallic Compounds of the Alkali Metals. – Organometallic Compounds of the Alkaline Earth Metals. – Grignard Reagents. – Organometallic Compounds of the Group 13, 14,15, and 12 Elements. 5. Organometallic Compounds of the Transition Elements – The 18-Electron Rule. 6. Transition Metal Carbonyls – Bonding in Carbonyl Compounds. – Evidence for Synergetic Bonding. – Types of Carbonyl Ligands. 7. Synthesis and Properties of Simple Metal Carbonyls – Carbonyls of the Groups 4 – 11 Elements. 8. Reactions of Transition Metal Carbonyls 9. Other Carbonyl Compounds – Metal Carbonyl Anions. – Metal Carbonyl Hydrides. – Metal Carbonyl Halides. 10. Complexes with Phosphine Ligands 11. Complexes with Alkyl, Alkene, and Alkyne Ligands, Synthesis of Transition Metal Alkyls 12. Complexes with Allyl and 1,3-Butadiene Ligands 13. Metallocenes 14. Complexes with η^6-Arene Ligands

	15. Complexes with Cycloheptatriene and Cyclooctatetraene Ligands 16. Fluxionality 17. Organometallic Compounds in Industrial Catalysis – Acetic Acid Synthesis: The Monsanto Process. – Alkene Polymerization: The Ziegler – Natta Catalyst. – Hydrogenation of Alkenes: Wilkinson's Catalyst. – Hydroformylation.
Recommended reading	1. N. Klouras, "Organometallic Chemistry", Publications of University of Patras, 2007. 2. I. Haiduc, J.J. Zuckerman, "Basic Organometallic Chemistry", Translation: N. Klouras, Papazisis Publications, 1987. 3. G.O. Spessard, G.L. Miessler, "Organometallic Chemistry", Prentice Hall, 1997. 4. C. Elschenbroich, "Organometallics", 3rd Edition, Wiley-VCH Verlag-GmbH & Co, 2006. 5. R.H. Crabtree, "The Organometallic Chemistry of the Transition Metals", 3rd Edition, John Willey & Sons, 1994. 6. Omae, "Applications of Organometallic Compounds", John Willey & Sons, 2001.
Teaching and learning methods	Lectures using power-point presentations and personal website. Problem-solving seminars during the lecture presentation.
Assessment and grading methods	Final written examination. Greek grading scale: 1 to 10. Minimum passing grade: 5.
Language of instruction	Greek

Special Topics in Physical Chemistry

Course title	Special Topics in Physical Chemistry
Course code	**XA736**
Type of course	Optional (Chemistry course)
Level of course	Undergraduate
Year of study	4th
Semester	7th
ECTS credits	5
Name of lecturer(s)	Prof. G. Karaiskakis
Learning outcomes	At the end of this course the student should be able to: 1. Know the basic physicochemical principles of the physical methods of separation. 2. Apply the basic principles of the mass transport phenomena to the understanding of the resolution of the separation methods. 3. Apply the chromatographic techniques to the determination of basic physicochemical parameters.
Competences	At the end of the course the student will have further developed the following skills/competences: 1. Ability to demonstrate knowledge and understanding of essential principles, concepts and theories relating to the chromatographic techniques especially. 2. Ability to apply such knowledge to the simultaneous determination of essential physicochemical quantities. 3. Study and laboratorial skills needed for continuous professional development.
Prerequisites	There are no prerequisite courses. It is however recommended that students should have at least a basic knowledge of Physical Chemistry and Analytical Chemistry.

Course contents	1. Physicochemical principles of the physical methods of separation. 2. Mass transport phenomena. 3. Physicochemical applications of the chromatographic techniques.
Recommended reading	1. G. Karaiskakis, "Physicochemical Aspects of the Physical Methods of Analysis", Publications of University of Patras, 2000. 2. R.J. Laub, R.L. Pecsok,"Physicochemical Applications of Gas Chromatography", John Wiley & Sons, 1978.
Teaching and learning methods	Problem-solving seminars for the easier and more complete understanding of the course contents.
Assessment and grading methods	1. Two (2) optional tests. 2. Written finalexamination. The final mark results from the contribution of the final examination and the optional tests with different weightiness. Greek grading scale: 1 to 10. Minimum passing grade: 5. Grades ≤3 correspond to ECTS grade F. Grade 4 corresponds to ECTS grade FX. For the passing grades the following correspondence normally holds: 5 ↔ E, 6 ↔ D, 7 ↔ C, 8 ↔ B and ≥9 ↔ A
Language of instruction	Greek. Instruction may be given in English if foreign students attend the course.

Quality Control in Analytical Chemistry

Course title	Quality Control in Analytical Chemistry
Course code	**XE755**
Type of course	Optional (Chemistry course)
Level of course	Undergraduate
Year of study	4th
Semester	7th
ECTS credits	5
Name of lecturer(s)	Prof. Th. Christopoulos, Lect. D. Kalogianni
Learning outcomes	• Quality characteristics of analytical methods such as: accuracy, reproducibility, repeatability, detectability, sensitivity, specificity, robustness. • Experimental approaches used for the evaluation of the quality characteristics of analytical methods. • Calibration of analytical methods. • Experimental design and method optimization. • Analysis of variance. • Method validation. Acceptance criteria. • Traceability. • Method comparison studies. • Intra- and inter-laboratory quality control systems. • Laboratory accreditation. • Quality assurance. • ISO standards. • Understand and appreciate the importance of sampling issues in chemical analysis.

Competences	The student will be able to: • Evaluate the performance of analytical methods and validate analytical methods. • Deal with internal and external quality control. • Carry out method comparison studies. • Organize the accreditation of a laboratory. • Apply ISO to an analytical laboratory. • Develop appropriate sampling strategies.
Prerequisites	None
Course contents	• Quality characteristics of analytical methods such as: accuracy, reproducibility, repeatability, detectability, sensitivity, specificity, robustness. • Experimental approaches used for the evaluation of the quality characteristics of analytical methods. • Calibration of analytical methods. • Experimental design and method optimization. • Analysis of variance. • Method validation. Acceptance criteria. • Traceability. • Method comparison studies. • Intra- and inter-laboratory quality control systems. • Laboratory accreditation. • Quality assurance. • ISO standards. • Understand and appreciate the importance of sampling issues in chemical analysis.
Recommended reading	Lecture notes.
Teaching and learning methods	PowerPoint presentation.
Assessment and grading methods	Assignments and written examination.
Language of instruction	Greek or English.

Catalysis

Course title	Catalysis
Course code	**XE791**
Type of course	Optional (Chemistry course)
Level of course	Undergraduate
Year of study	4th
Semester	7th
ECTS credits	5
Name of lecturer(s)	Prof. Ch. Kordulis
Learning outcomes	At the end of this course the student should be able to: • Present the fundamental concepts and methods of the homogeneous and heterogeneous catalysis including enzymatic catalysis, photocatalysis and electrocatalysis.

	• Classify the catalysts and the catalytic reactions in important groups presenting the fundamental aspects of the catalytic action related to each catalytic group. • Present the structure and the methods of preparation and characterization of the solid catalysts as well as the assesment of the catalytic performance. • Explain the contribution of catalysis in the chemical industry and pollutant devastation as well as in the production and improvement of traditional and environmentally friendly fuels and processes.
Competences	At the end of this course the student should be able to • Select the appropriate catalyst for a given catalytic process-reaction. • Prepare a solid catalyst. • Obtain a clear picture for the surface characteristics of a solid catalyst by combining the results of various characterization techniques. • Design suitable reactors and perform kinetic experiments for testing the activity and selectivity of a catalyst.
Prerequisites	There are no prerequisite courses. It is however recommended that students should have at least a basic knowledge on General, Inorganic, Organic and Analytical Chemistry as well as on Chemical Reactors.
Course contents	• Introduction • Catalysis by acids and bases in solutions • Catalysis by transition metal complexes in solutions • EnzymeCatalysis • Acid-Base Catalysis at surfaces-zeolites • Partial oxidation on transition metal oxides • Catalysis by metals • Hydro treatment of oils over supported metal sulfides • Photocatalysis • Electrocatalysis • Structure and texture of the solid catalysts • Synthesis of catalytic supports and non-supported catalysts • Synthesis of supported catalysts • Determination of geometrical characteristics of solid catalysts • Determination of chemical characteristics of solid catalysts • Determination of kineticparameters: Laboratory catalytic reactors • Surface kinetics • Literature
Recommended reading	1. A. Lycourghiotis and Ch. Kordulis,"Catalysis (an undergraduate course)", Publications of University of Patras, 2010. 2. A. Lycourghiotis,"Introduction to contact catalysis", Stamoulis Publications, 1987. 3. I.M. Campbell,"Catalysis at Surfaces", Chapman and Hall Ltd., 1988. 4. R.A. Van Santen,"Theoretical Heterogeneous Catalysis", World Scientific Lecture and Course Notes in Chemistry, Vol. 5, World Scientific Publishing Co., 1991. 5. B. C. Gates, "Catalytic Chemistry", The Wiley Series in Chemical Engineering, Wiley, 1992. 6. J.A. Moulijn, P.W.N.M. van Leeuwen, R.A. van Santen (editors), "Catalysis: an integrated approach to homogeneous, heterogeneous and industrial catalysis", Studies in surface science and catalysis, Elsevier, 1993. 7. J.M. Thomas, W.J. Thomas, "Principles and Practice of Heterogeneous Catalysis", VCH, 1997.

	8. G. Ertl, H. Knözinger, F. Schüth, J. Weitkamp (editors), "Handbook of Heterogeneous Catalysis", Volumes 1-8, 2nd Edition, Wiley-VCH, 2008. 9. R.J. Wijngaarden, A. Kronberg, K.R. Westerterp, "Industrial Catalysis: Optimizing Catalysts and Processes", Wiley-VCH Verlag GmbH, 1998. 10. B. Cornils and W.A. Herrmann, M. Muhler, C.-H. Wong (editors), "Catalysis from A to Z: A Concise Encyclopedia", Volumes 1-3, 3rd Edition, Wiley-VCH, 2007. 11. J. Hagen, "Industrial Catalysis: A Practical Approach", 2nd Edition, Wiley-VCH Verlag GmbH, 2006. 12. A. LycourghiotisandCh. Kordulis,"Catalysis", Volume I,Hellenic Open University, 2003. 13. Ch. KordulisandA. Lycourghiotis,"Catalytic Surfaces", Helenic Open University, 2003.
Teaching and learning methods	Lectures and tutorials using power-point presentations.
Assessment and grading methods	Written examinations during the course or final written examinations
Language of instruction	Greek

Biochemistry-3 (Gene expression and regulation–Gene engineering)

Course title	Biochemistry-3 (Gene expression and regulation–Gene engineering)
Course code	**XA712**
Type of course	Optional (Chemistry course)
Level of course	Undergraduate
Year of study	4th
Semester	7th
ECTS credits	5
Name of lecturer(s)	Lectures and Laboratory: Assoc. Prof. A. Aletras, Prof. D. Vynios, Assist. Prof. S. Skandalis
Learning outcomes	At the end of this course the student should be able to: 1. Present the most important aspects of gene expression and regulation. 2. Recognise the critical steps of gene expression. 3. Evaluate the specificity of gene expression and possible applications in genetic engineering. 4. Combine and apply the appropriate methodologies for the production of recombinant proteins.
Competences	At the end of the course the student will have further developed the following skills/competences 1. Ability to demonstrate knowledge and understanding of essential facts, concepts, principles and theories relating to gene expression. 2. Ability to apply such knowledge and understanding to the solution of qualitative and quantitative problems of an unfamiliar nature. 3. Ability to adopt and apply methodology to the solution of unfamiliar problems. 4. Study skills needed for continuing professional development. 5. Ability to interact with others on inter or multidisciplinary problems.
Prerequisites	There are no prerequisite courses. It is however recommended that students should have at least a basic knowledge ofBiology and Biochemistry.
Course contents	1. Gene expression.

	2. Regulation of gene expression, hormonal and epigenetic regulation, the role of chromatin, of histones, and of protein-protein interactions in gene expression. 3. Post-transcriptional regulation of gene expression. 4. RNA interference. 5. Genetic engineering. 6. Restriction enzymes. 7. PCR. 8. Recombinant DNA technology. 9. DNA manipulation. 10. Cell transfection. 11. Recombinant proteins.
Recommended reading	1. J.M. Berg, J.L. Tymoczko, L. Stryer, "Biochemistry", Volume I and II, Translation: A. Aletras, Th. Valkana, D. Drainas et al., Creta University Press, 2005. 2. B. Lewin, "Genes VIII", Volume I & II, 8th Edition, Translation: G. Stamatogiannopoulos, University Publications I. Mpasdras, 2004.
Teaching and learning methods	Lectures using power-point presentations and multimedia. Problem-solving work by the students.
Assessment and grading methods	1 Writtenexamination of the theory (2/3 of the final mark) 2 Oral presentations by the students (1/3 of the final mark) Both marks should be ≥5. Greek grading scale: 1 to 10. Minimum passing grade: 5. Grades ≤3 correspond to ECTS grade F. Grade 4 corresponds to ECTS grade FX. For the passing grades the following correspondence normally holds: 5 ↔ E, 6 ↔ D, 7 ↔ C, 8 ↔ B and ≥9 ↔ A
Language of instruction	Greek

Clinical Chemistry

Course title	Clinical Chemistry
Course code	**XA713**
Type of course	Optional (Chemistry course)
Level of course	Undergraduate
Year of study	4th
Semester	7th
ECTS credits	5
Name of lecturer(s)	Lectures: Prof. N. Karamanos, Assoc. Prof. A. Theocharis Laboratory: Prof. N. Karamanos, Prof. D. Vynios, Assoc. Prof. A. Theocharis,
Learning outcomes	At the end of this course the student should be able to: 1. Recognize and apply the basic analytical techniques and methods of evaluation in the clinical chemistry laboratory. 2. Evaluate the analytical data of the clinical laboratory in regards to the pathophysiological situations.
Competences	At the end of the course the student will have further developed the following skills/competences: 1. Ability to demonstrate knowledge and understanding of essential facts, concepts,

	principles and theories related to clinical chemistry. 2. Ability to apply such knowledge and understanding to clinical chemistry laboratory and to expand his/her education to more complex issues of clinical biochemistry. 3. Study skills needed for continuing professional development. 4. Ability to interact with others on inter or multidisciplinary problems. 5. Ability to adopt and apply methodology for the solution of unfamiliar problems.
Prerequisites	There are no prerequisite courses. It is however recommended the students should have at least a basic knowledge of biochemistry and general biology.
Course contents	1. *Methods of separation and analysis.* Laboratory techniques of separation and analysis. Molecular diagnostic techniques. 2. *Quality control in clinical chemistry laboratory.* Reliability of methods, faults and errors, physiological values, choice and development of analytical methods, quality control, reception and processing of biological material. 3. *Analysis of aminoacids, proteins and enzymes in clinical chemistry.* Analysis of aminoacids and derivates. Hemoglobins, plasma proteins, proteins of urine and encephalospinal fluid. Changes of enzymes in diseases, localization. 4. *Analysis of carbohydrates, lipids and lipoproteins.* Control of carbohydrates, lipids and lipoproteins in pathological situations. 5. *Control of endocrine system.* Control of thyroid, suprarenal glands, hypophysis and gonads. 6. *Acid-base balance, electrolytes and renal function.* Control of acid-base balance, electrolyte concentration and renal function. 7. *Control of hepatic, gastric, pancreatic and intestinal function.* Control of hepatic, gastric, pancreatic and intestinal function. Indicatorsofdysfunction. 8. *Laboratory courses. Analysis of biological samples and indicators of diagnostic interest.* Analysis of blood and urine. Analysis of carbohydrates, hemoglobins, proteins, lipoproteins, urea, bilerubine, transaminases, cholesterol, triglycerides, alkaline phosphatase isoenzymes, clearance test.
Recommended reading	1. I. Georgatsos, P. Arzoglou, "Principles of clinical chemistry", Giaxoudis-Giapoulis Publications, 1999. 2. A. Skorilas, "Principles of clinical chemistry and molecular diagnostic", Symmetria Publications, 2009. 3. P. Karlson, W. Gerok, W. Grob, "Clinical Pathobiochemistry", Translation: K. Sekeris, Litsas Medical Publications, 1993.
Teaching and learning methods	Lectures using PowerPoint presentations.
Assessment and grading methods	Written examinations.
Language of instruction	Greek

Semi-optional Courses (three courses/15 ECTS credits)

Chemical Technology-2 (Special Topics of Physical Processes)

Course title	Chemical Technology-2 (Special Topics of Physical Processes)
Course code	**XE882**
Type of course	Semi-Optional
Level of course	Undergraduate
Year of study	4th
Semester	8th
ECTS credits	5
Name of lecturer(s)	Prof. Ch. Kordulis, Prof. I. Kallitsis
Learning outcomes	At the end of this course the student should be able to 1. Apply the Chemical Technology Principles for solving problems related to mass and heat transfer taking place in Advanced Physical and Heterogeneous Chemical Processes, 2. Choose the best conditions for carrying out effectively physical processes such as diffusion mass transfer, size reduction membranes separations etc., 3. Determine deviation from the ideal flow in chemical reactors, 4. Choose the suitable performance conditions of heterogeneous chemical reactors, 5. Determine the rate equation of heterogeneous reactions, 6. Solve problems related to bio-reactors.
Competences	At the end of the course the student will have further developed the following skills/competences 1. Ability to demonstrate knowledge and understanding of essential facts, concepts, principles and theories relating to productive performance of advanced physical processes and heterogeneous chemical processes. 2. Ability to apply such knowledge and understanding to the solution of qualitative and quantitative problems of an unfamiliar nature. 3. Ability to adopt and apply methodology to the solution of unfamiliar problems. 4. Study skills needed for continuing professional development. 5. Ability to interact with others on inter or multidisciplinary problems.
Prerequisites	There are no prerequisite courses. It is however recommended that students should have at least a basic knowledge of Chemical Technology-1 and Physical Chemistry.
Course contents	Physical Processes Diffusion and Mass Transfer Size reduction and Mechanical Separations Crystallization Membrane Separation Processes Gas Absorption Liquid Extraction Chemical Processes Basics of Non-Ideal Flow Heterogeneous Reactions Solid Catalyzed Reactions

	The Packed Bed Catalytic Reactor Biochemical Reaction Systems
Recommended reading	1. W.L. McCabe, J.C. Smith, P. Harriott, "Unit operations of chemical engineering", 6th Edition, Translation: S. Polymatidou, Tziolas Publications, 2002. 2. I. Gentekakis, "Physical processes: analysis and design" Kleidarithmos Publications, 2010. 3. O. Levenspiel, "Chemical reaction engineering", Translation: F. Pomonis, K. Matis, N. Papagiannakos, et al., Kostarakis Publications, 2004. 4. P. Mavros, K. Matis, K. Triantafyllides, "Elements of chemical processes", Tziolas Publications, 2009.
Teaching and learning methods	Power-point presentations. Problem-solving seminars. Laboratory exercises performed by the students working in teams of four.
Assessment and grading methods	1) Two written examinations (one in the middle of the semester and one at the end), which substitute the final written one when the student secures the minimum mark of 7.0 in each one of them. 2) Problems given during the corresponding seminars solved by each student (20% addition of the mark of final written examination, taken into account only when the student secures the minimum mark of 5 in the final written examination) 3) Written examination Greek grading scale: 1 to 10. Minimum passing grade: 5. Grades ≤3 correspond to ECTS grade F. Grade 4 corresponds to ECTS grade FX. For the passing grades the following correspondence normally holds: 5 ↔ E, 6 ↔ D, 7 ↔ C, 8 ↔ B and ≥9 ↔ A
Language of instruction	Greek

Heterocyclic Chemistry and Principles of Pharmaceutical Chemistry

Course title	Heterocyclic Chemistry and Principles of Pharmaceutical Chemistry
Course code	**XO807**
Type of course	Semi-optional
Level of course	Undergraduate
Year of study	4th
Semester	8th
ECTS credits	5
Name of lecturer(s)	Assist. Prof. G. Rassias
Learning outcomes	At the end of this course the student should be able to 1. To name 3-6 membered aromatic or saturated heterocyclic compounds with one or more heteroatoms. 2. To describe and write mechanisms for the most important reactions for the synthesis of heterocyclic compounds like oxiranes, oxetanes, pyrroles, indoles, furans and thiophenes, pyridines, quinolines and isoquinolines, triazoles, tetrazoles, purines and pyrimidines. 3. Compare the aromaticity of pyrrole, furan, thiophen and pyridine with that of benzene, showing similarities and differences. Explain the different effect that nitrogen has on the chemistry of pyrrole and pyridine in realizing their contrasting chemical behavior. Relate the differing chemistry of pyrrole, furan and thiophene to the influence of the heteroatom.

	4. Predict the site of electrophilic or nucleophilic (where applicable) attack on heterocyclic compounds like pyrrole, furan, thiophen, pyridine, indole, quinoline and isoquinoline. 5. Recognize features of general organic chemistry in given examples of the chemistry of natural products. Predict the behaviour of natural products under given reaction conditions based on knowledge of general organic chemistry. 6. Recognize a given natural product as belonging to (a) the shikimic acid pathway, (b) the polyketide patway, (c) the mevalonic acid pathway, (d) the amino acids, peptides and proteins, (e) the alkaloids and (f) the *N*-heteroaromatics families of natural products. 7. Explain the ways through which the various living organisms in the environment communicate, react and defend. 8. Identify isoprene units in a given terpene using the isoprene rule. Propose a possible primary structure for a given oligopeptide based on chemical and biochemical information. 9. Devise a synthetic sequence for the synthesis of a given oligopeptide and a given oligonucleotide using appropriate protecting groups and coupling agents/conditions. 10. Utilizethe chemistry of the functional groups of monosaccharides in order to identify an "unknown" carbohydrate. 11. Propose a synthetic sequence for the preparation of a given disaccharide.
Competences	At the end of the course the student will have further developed the following skills/competences 1. Ability to demonstrate knowledge and understanding of essential facts, concepts, theories and applications relating to Heterocyclic Chemistry and Natural Product Chemistry 2. Ability to apply such knowledge and understanding to the solution of problems related to Heterocyclic Chemistry and Natural Products Chemistry of an unfamiliar nature. 3. Ability to adopt and apply methodology to the solution of unfamiliar problems. 4. Study skills needed for continuing professional development. 5. Ability to interact with others on inter or multidisciplinary problems.
Prerequisites	There are no prerequisite courses. It is, however, recommended that students should have at least a basic knowledge of Organic Chemistry.
Course contents	*1. Chemistry of Heterocyclic Compounds (26 hours)* Systematic nomenclature of heterocyclic compounds. Structure, synthesis, reactions and applications of the most interesting heterocyclic compounds with one or more heteroatoms, simple and fuzed. These include: • Three-membered heterocycles (oxirane, aziridine, dioxirane) • Four-membered heterocycles (oxetane, azetidine/azetidin-2-one) • Five-membered heterocycles (furan, pyrrole, thiophene, benzofuran, indole, oxazole, imidazole, triazoles, tetrazole • Six-membered heterocycles (pyridine, quinoline, isoquinoline, pyrimidine, purine, pteridine). *2. Natural Products Chemistry (26 hours)* Primary and Secondary Metabolism. Chemical Ecology (Introduction, plant-animal, animal-animal, plant-plant and plant-microorganism relationships). Carbohydrates and primary metabolites. The shikimic acid pathway (aromatic amino acids, cinnamic acids, coumarins, quinines, lignins).

	The polyketide pathway (fatty acids, prostaglandins, macrolides, anthraquinones, flavonoids, tropolones). The mevalonic acid pathway (The terpenes). Amino acids, peptides and proteins. The Alkaloids. *N*-Heteroaromatics (pyrimidines, purines, noukleotides, pteridines, pyrroles, porphyrines).
Recommended reading	1. T. Eicher, S. Hauptmann, A. Speicer, "The Chemistry of heterocycles: structure, reactions, syntheses, and applications", 2nd Edition, Wiley-VCH, 2003. 2. T.L. Gilchrist, "Heterocyclic chemistry", 3rd Edition, Longman, 1997. 3. K.B.G. Torssell, "Natural product chemistry: a mechanistic, biosynthetic and ecological approach", 2nd Edition, Apotekarsocieteten, Sweden Pharmaceutical Society, 1997. 4. J. Mann, R.S. Davidson, J.B. Hobbs, D.V. Banthorpe, J.B. Harborne, "Natural Products: their chemistry and biological significance", Longman Scientific & Technical, 1994.
Teaching and learning methods	Lectures using slides for overhead projector or powerpoint presentations. Problem-solving seminars for the instructive solution of problems related to the heterocyclic chemistry and the chemistry of natural products. Collaborative problem-solving work by the students working in teams of two.
Assessment and grading methods	1. Optionally, three assays with heterocyclic chemistry (two) and natural product chemistry (one) related problems solved by groups of two students (the 30% of the mean mark for the three assays is added to the final exams mark, taken however into account only when the student secures the minimum mark of 4 in the final written examination) 2. Written examination (2 questions on heterocyclic chemistry and 2 questions from natural product chemistry, final mark, unless the student participated in the preparation of the afore mentioned all three assays during the semester, in which case the final mark is calculated as described above). Greek grading scale: 1 to 10. Minimum passing grade: 5. Grades ≤3 correspond to ECTS grade F. Grade 4 corresponds to ECTS grade FX. For the passing grades, the following correspondence holds: 5 (or 5.5) ⇔ E, 6 (or 6.5) ⇔ D, 7 (or 7.5) ⇔ C, 8 (or 8.5) ⇔ B and ≥9 - 10 ⇔ A
Language of instruction	Greek. Instruction may be given in English in case foreign students attended the course.

Computational Chemistry

Course title	Computational Chemistry
Course code	**XA837**
Type of course	Semi-Optional
Level of course	Undergraduate
Year of study	4th
Semester	8th
ECTS credits	5
Name of lecturer(s)	Lectures and Laboratory: Prof. G. Maroulis
Learning outcomes	At the end of this course the student should be able to use computers to solve advanced problems in all fields of Chemistry.
Competences	At the end of the course the student will have further developed the following skills/competences: Advanced use of computers and in-depth exploration of the

	possibilities offered by the Internet.
Prerequisites	There are no prerequisite courses.
Course contents	A. Introduction to the use of computers/PCs to problem solving in Analytical Chemistry, Organic Chemistry, Physical Chemistry and Quantum Chemistry. Analysis of chemical information. Pattern recognition. Similarity and clustering. More general applications of computers: Cosmochemistry and Quantum Pharmacology. Artificial Intelligence. B. Dissociation of monoprotic acids. Dissociation of polyprotic acids H_nA Study of Mixtures of acids Finding the PH of a $Na_mH_{n-m}A + H_nA$ mixture Solubility in saturated solutions Titration simulation Maxwell-Boltzman distribution Propeties of the wavefunction of Schrödinger's equation.
Recommended reading	K.Ebert, H.Ederer & T.L.Isenhour, "Computer Applications in Chemistry", VCH, 1989.
Teaching and learning methods	Lectures and Laboratory.
Assessment and grading methods	Written examination.
Language of instruction	Greek

Structural Chemistry

Course title	Structural Chemistry
Course code	**XE861**
Type of course	Semi-Optional
Level of course	Undergraduate
Year of study	4th
Semester	8th
ECTS credits	5
Name of lecturer(s)	Prof. V. Nastopoulos
Learning outcomes	At the end of this course the student should be able to 1. Have a good understanding of the three-dimensional architecture of the various types of crystal structures. 2. Recognize the structural differences among the various types of crystal structures, and the impact of the structure upon their chemical and physicochemical properties and behaviour. 3. Combine and apply the knowledge obtained in other fields of Chemistry (e.g. Inorganic, Organic, Biochemistry etc.) in which certain notions and principles of structural chemistry are necessary and useful. 4. Understand the principles and the basics of a crystal/molecular structure determination.
Competences	At the end of the course the student will have further developed the following skills/competences: 1. Ability to demonstrate knowledge and understanding of essential concepts, principles and applications that are related to the structure of the various types of

	crystalline materials. 2. Ability to apply such knowledge to the solution of problems in other fields of Chemistry or inter/multidisciplinary problems. 3. Ability to use computers, specialized software and structural databases in order to investigate unfamiliar structural problems. 4. Study skills needed for continuing professional development.
Prerequisites	There are no prerequisite courses. It is, however, recommended that students should have a basic knowledge ofGeneral Chemistry.
Course contents	• Crystalline and amorphous state of matter. Crystal lattice, unit cell. Symmetry, point groups, chirality, crystal systems, Bravais lattices, space groups. • Types of crystalline compounds. Chemical bonds in crystals. Metalsandalloys. Ionic crystals, coordination, lattice energy. Covalent crystals, molecular crystals. Structure of macromolecules, polymers, nanostructures, etc. Liquid crystals. Representative compounds. • Basics of crystallochemistry. Crystal growth and defects. Crystal structure-properties relationship. • Principles of crystal structure determination: X-ray, neutron and electron diffraction, powder methods, electron microscopy. • Training with structural models, educational software, three-dimensional representation of crystal and molecular structures. Application to chemical and pharmaceutical molecules and biomolecules (proteins, DNA, RNA, complexes, viruses etc.). • Exploring the structural databases - Data mining.
Recommended reading	1. V. Nastopoulos, "Structural Chemistry", Publications of University of Patras, 2009. 2. S.M. Allen, E.L. Thomas, "The Structure of Materials", MIT Series in Materials science and Engineering, John Wiley & Sons, 1998. 3. W. Massa, "Crystal Structure Determination", 2nd Edition, Springer-Verlan, 2004.
Teaching and learning methods	Lectures using power-point presentations, structural models and multimedia. Training with models, educational software, three-dimensional representation of crystal and molecular structures. Application to representative crystal structures. Exploring the structural databases - Data mining and retrieval. Problem-solving.
Assessment and grading methods	1. Problem-solving by the students (20% of the final mark). 2. An assay at the end of the semester by each student (20% of the final mark). 3. (1 and 2 are taken into account only when the student secures the minimum mark of 5 in the final written examination). 4. Written examination (60% of the final mark). Greek grading scale: 1 to 10. Minimum passing grade: 5. Grades ≤3 correspond to ECTS grade F. Grade 4 corresponds to ECTS grade FX. For the passing grades the following correspondence normally holds: 5 ↔ E, 6 ↔ D, 7 ↔ C, 8 ↔ B and ≥9 ↔ A
Language of instruction	Greek

Optional (Elective) Courses
(one course/5 ECTS credits)

Food Biochemistry

Course title	Food Biochemistry
Course code	**XO814**
Type of course	Optional (Chemistry course)
Level of course	Undergraduate
Year of study	4th
Semester	8th
ECTS credits	5
Name of lecturer(s)	Assist. Prof. A. Vlamis
Learning outcomes	At the end of this course the student should be able to: 1. Know in general the composition of various foods in carbohydrates, proteins, lipids, vitamins, pigments etc. and the role of these constituents in foods. 2 Know in general about the food enzymes, their role, and which the enzymes that are used in food processing. 3. Know in general about the food alterations and the biochemical basis of carbohydrates, proteins, lipids, vitamins, pigments etc changes that occur. 4. Know in general about the effect of several food treatments on carbohydrates, proteins, lipids, vitamins, pigments etc. and their chemical basis. 5. Know the biochemical processes that occur during fruits ripening and meat tenderization.
Competences	At the end of the course the student will have further developed the following skills/competences 1. Ability to demonstrate knowledge and understanding of essential facts, concepts, principles and theories relating to role and importance of carbohydrates, lipids, proteins, vitamins, pigments etc. in foods, as well as the biochemical processes that occur and affect these constituents during of foods processing. 2. Ability to apply such knowledge and understanding to the solution of qualitative and quantitative problems of an unfamiliar nature. 3. Ability to adopt and apply methodology to the solution of unfamiliar problems. 4. Study skills needed for continuing professional development. 5. Ability to interact with others on inter or multidisciplinary problems.
Prerequisites	There are no prerequisite courses. It is however recommended that students should have at least a basic knowledge of Organic Chemistry and Biochemistry.
Course contents	1. Carbohydrates. The role of carbohydrates in foods. Changes of carbohydrates during foods processing (Hydrolysis, crystallization, isomerisation, dehydration, non-enzymatic browning). 2. Lipids and oils. The role of lipids in foods. Changes of lipids during foods processing (polymerization, lipolysis, oxidation, self-oxidation). Effect of self-oxidation on the structure, color, taste and smell of lipids. 3. Proteins. Proteins in foods. Proteins of meat and seafoods. Post-mortem biochemical changes of proteins. The milk proteins and their role in cheese production. Proteins of eggs, seeds, and vegetables, their nutritional significance. Effects of foods processing on proteins. 4. Natural pigments in foods. Chlorophylls, carotenoids, phenolic compounds. 5. Biochemical processes, occurred during fruits ripening and meat tenderization that affect the food texture, color, taste and smell. 6. Enzymes. Enzymes in foods. Factors that affect the enzyme activity during foods processing. Application of enzymes in foods technology. Enzymes hydrolyzing

	carbohydrates, proteolytic enzymes, lipolytic enzymes, oxidoreductases. 7. Enzymatic browning. Reaction mechanism, polyphenolases. Methods of enzymatic browning control and restriction. 8. Vitamins. Fat-soluble and water-soluble vitamins. Vitamins in foods. Vitamins loss during foods processing. 9. Food additives. Conservatives, taste and smell additives, pigments, structure additives. 10. Alterations of foods by microorganisms (Biodegradation).
Recommended reading	1. A. Vafopoulou-Mastrogiannaki, "Food Biochemistry", Ziti Publications, 2003. 2. D. Galanopoulou, J. Zampetakis, M.-Mavri-Vavagianni,A. Siafaka, "Food Biochemistry", Stamoulis Publications, 2007.
Teaching and learning methods	Lectures using power-point presentations and/or slides for overhead projector.
Assessment and grading methods	Written examination. Greek grading scale: 1 to 10. Minimum passing grade: 5. Grades ≤3 correspond to ECTS grade F. Grade 4 corresponds to ECTS grade FX. For the passing grades the following correspondence normally holds: 5 ↔ E, 6 ↔ D, 7 ↔ C, 8 ↔ B and ≥9 ↔ A
Language of instruction	Greek

Introduction to Molecular Design

Course title	Introduction to Molecular Design
Course code	**XA838**
Type of course	Optional (Chemistry course)
Level of course	Undergraduate
Year of study	4th
Semester	8th
ECTS credits	5
Name of lecturer(s)	Prof. G. Maroulis
Learning outcomes	Nature and energetic content of the chemical bond, calculation and plotting of HOMO-LUMO. Calculation of the molecular geometry.
Competences	At the end of the course the student will have further developed the use of advanced and specialized software for widerapplication in chemistry: spectroscopy, molecular modelling in Organic and Inorganic Chemistry.
Prerequisites	Physical Chemistry II and Computational Chemistry.
Course contents	• Chemical Graph Theory. • Topological Matrix and Hückel Molecular Orbital Theory. • Molecular complexity. • Quantitative Structure-Property Relationships (QSPR). • Quantitative Structure-Activity Relationships (QSAR). • Introduction to Molecular Mechanics (MM). • Molecular Design. • Applications to Medicinal Chemistry. *Practical/Laboratory courses*

	• Ab initio calculations for small organic and inorganic molecules. • Molecular structure and electronic strycture of small molecules. • Peptides and proteins. • Structure and conformation in oligopeptides.
Recommended reading	1. A.Hinchliffe, "Molecular Modelling for Beginners", Wiley, 2008.
Teaching and learning methods	Lectures and laboratory practice.
Assessment and grading methods	Compulsory project and/or Written examination.
Language of instruction	Greek

Bioinorganic Chemistry

Course title	Bioinorganic Chemistry
Course code	**XA826**
Type of course	Optional (Chemistry course)
Level of course	Undergraduate
Year of study	4th
Semester	8th
ECTS credits	5
Name of lecturer(s)	Prof. S. Perlepes, Assist. Prof. V. Tangoulis
Learning outcomes	At the end of this course the student should be able to 1. Discuss the role of metal ions that are used in living organisms and explain why nature might have chosen them. 2. Explain how the metal ions get into cells and how their concentrations are regulated. 3. Describe how metal ions bind to biopolymers, how metal ion binding can fold biopolymers leading to function, and how they are inserted into their active centers. 4. Understand the major roles of metal ions in biological systems, as electron carriers, centers for binding and activating substrates, agents for transferring atoms and groups, and as "bioinorganic chips". 5. Know the employment of metal complexes in Medicine. 6. Describe the toxic and environmentally harmful effects of metal ions, including the ways in which such toxicities are overcome both by the natural systems and by human intervention. 7. Know the role of inorganic elements in nutrition. 8. Design small metal complexes as structural and/or functional models for the metalloenzymes' active centers.
Competences	At the end of the course the student will have further developed the following skills/competences: 1. Ability to demonstrate knowledge and understanding of concepts and principles related to the study of naturally occurring inorganic elements in Biology, the introduction of metals into biological systems as probes and drugs, the role of metal ions in nutrition, the toxicity of inorganic species, and the metal-ion transport and storage in Biology. 2. Ability to apply such knowledge and in-depth understanding to solve problems of unfamiliar nature. 3. Ability to interact with others on interdisciplinary problems and to present

	literature reports.
Prerequisites	There are no prerequisite courses. It is however recommended that students should have at least a good knowledge of Coordination Chemistry and an elementary knowledge in Biology.
Course contents	1. Bioinorganic Chemistry: Introduction a) Definitions. b) Metal functions in metalloproteins. c) Metal functions in metalloenzymes. d) Communication roles for metal ions in Biology. e) Interactions of metal ions and nucleic acids. f) Metal-ion transport and storage in Biology. g) Metals in Medicine. 2. Properties of Biological Molecules a) Proteins. b) Nucleic acids. c) Other metal-binding biomolecules. 3. Physical Methods in Bioinorganic Chemistry a) Time scales. b) X-ray methods. c) Spectroscopic methods. d) Magnetic measurements. e) Electrochemistry. 4. Choice, Uptake and Assembly of Metal-Containing Units in Biology a) Bioavailability of metal ions. b) Intracellular chemistry of metal ions. c) Spontaneous self-assembly of metal clusters. 5. Control and Utilization of Metal-Ion Concentration in Cells a) Beneficial and toxic effects of metal ions. b) The generation and uses of metal-ion-concentration gradients. 6. Metal-Ion Folding and Cross-Linking of Biomolecules a) Stabilization of protein structure by metal ions. b) Stabilization of nucleic acid structure by metal ions. c) Protein binding to metallated DNA. d) Metallointercalators. 7. Binding of Metal Ions and Complexes to Biomolecule-Active Centers a) Selection and insertion of metal ions for protein sites. b) Preservation of electroneutrality. c) Metal-ion and metal-complex binding to nucleic acids. 8. Electron-Transfer Proteins a) Electron carriers. b) Long-distance electron transfer. 9. Substrate Binding and Activation by Nonredox Mechanisms a) Hydrolytic enzymes. b) Carbonic anhydrase and alcohol dehydrogenase. c) Nucleotide activation. 10. Atom- and Group-Transfer Chemistry

	a) Dioxygen transport. b) Oxygen-atom-transfer reactions. c) The Cu-Zn superoxide dismutase, catalase and peroxidases. 11. Metal Complexes in Medicine a) Metal complexes in nutrition. b) Anticancer activity of metal complexes. c) Diagnostic agents. d) Chelation therapy for removal of iron overload and toxic overloads of other metal ions. 12. Bioinorganic Catalysis a) Introduction. b) Catalysis by nitrogenases and synthetic analogs. c) Catalysis by nickel in biological systems. d) Oxygen activation at nonheme iron centers.
Recommended reading	1. S.J. Lippard, J.M. Berg, "Principles of Bioinorganic Chemistry", University Science Books, 1994. 2. R.M. Roat-Malone, "Bioinorganic Chemistry: A Short Course", Wiley-Interscience, 2002. 3. R.W. Hay, "Bioinorganic Chemistry", Translation: E. Manesi-Zoupa, D. Raptis, Papazisis Publications, 1992.
Teaching and learning methods	Lectures using slides for overhead projector and power-point presentations. Problem-solving seminars. Collaborative problem-solving work and presentations by the students working in pairs.
Assessment and grading methods	1. Written examination (50% of the final mark). 2. An assay comprising the writing of one literature report accompanied by an oral presentation (50% of the final mark).
Language of instruction	Greek

Biotechnology

Course title	Biotechnology
Course code	**XO815**
Type of course	Optional (Chemistry course)
Level of course	Undergraduate
Year of study	4th
Semester	8th
ECTS credits	5
Name of lecturer(s)	Lectures and laboratory: Prof. D. Vynios, Assist. Prof. S. Skandalis
Learning outcomes	At the end of this course the student should be able to 1. Present the most important applications of biological processes for the industrial (large scale) production of chemicals, pharmaceuticals, food and food additives, fuels, etc. 2. Recognise the critical steps in industrial processes. 3. Evaluate the methodologies for biotechnological products production. 4. Combine and apply the appropriate methodologies for the production of new chemicals, pharmaceuticals, etc.
Competences	At the end of the course the student will have further developed the following

	skills/competences 1. Ability to demonstrate knowledge and understanding of essential facts, concepts, principles and theories relating to Biotechnology. 2. Ability to apply such knowledge and understanding to the solution of qualitative and quantitative problems of an unfamiliar nature. 3. Ability to adopt and apply methodology to the solution of unfamiliar problems. 4. Study skills needed for continuing professional development. 5. Ability to interact with others on inter or multidisciplinary problems.
Prerequisites	There are no prerequisite courses. It is however recommended that students should have at least a basic knowledge ofBiology, Biochemistry, Molecular Biology, Mikrobiology, Chemical Technology and Organic Chemistry.
Course contents	1. Historical background. 2. Microbial culture growth (upstream processing): kinetics and bioreactors. 3. Biotechnological applications of microorganisms. 4. Downstream processing: large scale separation, purification and production of proteins and enzymes. 5. Immobilised biocatalysts and their applications. 6. Protein and enzyme modifications. 7. Biocatalysis, biotransformation in organic solvents. 8. Animal cell cultures, monoclonal antibodies. 9. Genetic engineering and applications. 10. Laboratory excercises a. Isolation and characterisation of alcohol dehydrogenase from yeast. b. Immobilisation of enzymes on various solid pases and their application in different types of bioreactors. c. Enzymatic reactions in organic solvents. d. Applications of enzymes in food industry and environment (Multimedia). e. Pharmacogenomics (Multimedia).
Recommended reading	1. D.A. Kyriakides, "Biotechnology", 2nd Edition, Zitis Publications, 2002. 2. V. Moses, R.E. Cape, D.G. Springham (editors), "Biotechnology: The Science and the Business", Harwood Academic Publishers, 1999. 3. D.Vynios, "Laboratory Practice in Biotechnology", Publications of University of Patras.
Teaching and learning methods	Lectures using power-point presentations and multimedia. Laboratory excercises of biotechnological applications. Problem-solving work by the students.
Assessment and grading methods	1 A review work in an advanced thematic issue by each student, followed by a 30min multimedia presentation (70% of the final mark, taken into account only when the student secures the minimum mark of 5 in the final written examination) 2 Written examination (30% of the final mark) Greek grading scale: 1 to 10. Minimum passing grade: 5. Grades ≤3 correspond to ECTS grade F. Grade 4 corresponds to ECTS grade FX. For the passing grades the following correspondence normally holds: 5 ↔ E, 6 ↔ D, 7 ↔ C, 8 ↔ B and ≥9 ↔ A
Language of instruction	Greek

Organic Industrial Products and Green Chemistry

Course title	Organic Industrial Products and Green Chemistry
Course code	**XO808**
Type of course	Optional (Chemistry course)
Level of course	Undergraduate
Year of study	4th
Semester	8th
ECTS credits	5
Name of lecturer(s)	Assist. Prof. G. Rassias, Prof. Th. Tsegenidis
Learning outcomes	At the end of this course the student should be able to 1. Present: a)the most important methods for the preparation of chemicals which are necessary for the quality of life of our society and b) methods and processes that protect our health, the environment and promote sustainable development. 2. Apply the principles of green chemistry for: a) the design of products that are safe for man and the environment,b) the design of innovative processes for sustainable industry and c) the design of products from renewables. 3. Evaluate chemical processes that produce less wastes (liquids, solids, gases) necessary factors for sustainability. 4. Use and apply the principles of the principles of green chemistry in the design and synthesis of organic compounds that are used in every day life.
Competences	At the end of the course the student will have further developed the following skills/competences 1. Ability to demonstrate knowledge and understanding of essential facts, concepts, principles and theories relating to he design and production of safe for health and environment organic products. 2. Ability to apply such knowledge and understanding to the solution of qualitative and quantitative problems of an unfamiliar nature. 3. Ability to adopt and apply methodology to the solution of unfamiliar problems. 4. Study skills needed for continuing professional development. 5. Ability to interact with others on inter or multidisciplinary problems.
Prerequisites	There are no prerequisite courses. It is however recommended that students should have at least a basic knowledge of Organic Chemistry.
Course contents	*1. Green Chemistry* Philosophy, principles, tools. *2. From lab to industrial scale* *3. Basic raw materials-Petrochemical processes –Biorefinery* Biomass, biorefinery, goal, natural gas, petroleum. Fractional distillation, petrochemical processes, applications of petrochemical processes, catalytic alkylations. *4. Aromatic intermediate materials* Raw materials, industrial processes: electrophilic substitution, halogenation, nitration, soulphonation, carboxylation, Friedel-Craft alkylation, diazonium salts as electrophiles, oxidation-reduction. Benzene derivatives and its application to industrial production of phenol, chlorobenzene, 2,4,5-trichlorophenol (TCP). Naphalene derivatives, Organic products for production of everyday goods applying green processes. Food additives, antioxidants, hair colours, sun protecting agents, photography materials, polymers from biomass, green solvents. *5. Fats and oils* Chemical composition and chemical reactions of fat and oils, fatty alcohols, fatty acids and esters, production of biodiezel. *6. Soaps*

	Classes, action, production. *7. Detergents* Synthetic detergents, classes, synthesis of cationic, anionic and non-ionic detergents, applications. *8. Paints* Introduction and applications to textile industry. *9. Explosives* *10. Agrochemicals* History, definition and their necessity, properties and classes, Natural pesticides: nicotinoides, rotenoids, pyrethroids, Decamethrine synthesis, all classes of synthetic pesticidesand their action, philosophy of the new generation of pesticides, phytohormones and growth regulators: growth hormones, ethylene, hormone inhibitors, strigol, Glycinoeclepti A, hormones and growth factors of insects, immune system in insects, pheromones, nitrogen fixation and photosynthesis. *11. Pharmaceuticals* Definition and necessity, disinfectants, sulphonamides, medicines for tuberculosis, antibiotics, steroids, drugs which caused social revolutions in the 20th century. Green chemistry and pharmaceutical industry. *12. Sweetwners* Definition and necessity, natural sweeteners, synthetic sweeteners: derivatives of sulphamic acid, saccharine, aspartame. *13. Fragrances* Definition, natural and synthetic fragrances.
Recommended reading	1. C. Poulos, "Industrial Organic Products", Publications of University of Patras. 2. H.A. Wittcoff, B.G. Reuben, J.S. Plotkin, "IndustrialOrganicChemicals", JohnWiley&SonsInc, 2004. 3. M.M. Green, H.A. Wittcoff, "OrganicChemical Principles and Industrial Practice", Wiley-VCH, 2003. 4. B.G. Reuben, H.A. Wittcoff, "Pharmaceutical Chemicals in Perspective", John Wiley & Sons Inc., 1989. 5. H.O. House, "Modern Synthetic Reactions", The Benjamin/Cummings Publishing Co, 1972. 6. J. Fuhrhop, G. Penzlin, "Organic Synthesis", Verlag Chemie, 1984. 7. K. Weissermel, H.-J. Arpe, "Industrial Organic Chemistry", 3rd Edition, VCH, 1997. 8. P. Anastas, T. Williamson, "Green Chemistry", Oxford University Press,1998. 9. D. Warren, "Green Chemistry: A resource outlining areas for the teaching of green and environmental chemistry and sustainable development for 11-19 year old students", Royal Society of Chemistry, 2001. 10. P. Tundo, P. Anastas (editors), "Green Chemistry: Challenging Perspectives", Oxford University Press, 2000. 11. P.T. Anastas, J.C. Warner, "Green Chemistry: Theory and Practice", Translation: K. Ampeliotis, M. Kapassa, P. Siskos, Creta University Press, 2007. 12. M. Lancaster, "Green Chemistry: An Introductory Text", Royal Society of Chemistry, 2002. 13. J. Clark, D. MacQuarrie (editors), "Handbook of Green Chemistry and Technology", Blackwell Science, 2002. 14. A.S. Matlack, "Introduction to Green Chemistry", Marcel Dekker, Inc., 2001.
Teaching and learning methods	Lectures using slides for overhead projector and/or power-point presentations. Problem-solving seminars for the instructive solution of synthetic problems. Collaborative problem-solving work by the students working in teams of two or three.
Assessment and	• A group of 2 or 3 students write an essay (min.15 pages A4) on a topic chosen from

grading methods	those in the course content and after searching the literature (40% of the final mark). • They present their work orally using PowerPoint (40% of the final mark). • After the presentation are asked questions from the instructor (20% of the final mark).
Language of instruction	Greek. Instruction may be given in English if foreign students attend the course.

Polymer Science

Course title	Polymer Science
Course code	**XE883**
Type of course	Optional (Chemistry course)
Level of course	Undergraduate
Year of study	4th
Semester	8th
ECTS credits	5
Name of lecturer(s)	Assist. Prof. Ch. Deimede
Learning outcomes	At the end of this course the student should be able to 1. Know the basic synthetic methods of polymers using the step-growth, free radical, anionic and cationic polymerization. 2. Know the most important industrial polymers, their synthetic methods, properties and technological applications. 3. Know the methods for the synthesis of copolymers and particularly of graft and block copolymers. 4. Combine and apply the appropriate methods for the production of new polymers and forecast their properties.
Competences	At the end of the course the student will have further developed the following skills/competences 1. Ability to demonstrate knowledge and understanding of essential concepts and methods for the synthesis of polymers with different chemical structures and properties. 2. Ability to recognize various polymers and suggest methods for their synthesis. 3. Ability to work in the production and processing of polymers.
Prerequisites	There are no prerequisite courses**.** It is however recommended that students should have at least a basic knowledge ofOrganic Chemistry.
Course contents	1. *Introduction.* 1.1. Classification and basic definitions. 1.2. Nomenclature. 2. *Step-growth polymerization.* 2.1. Polyesters. 2.2. Polyamides. 2.3. Polyurethanes. 2.4. Epoxy resins. 2.5. Thermosetting polymers. 2.6. Heat-resistant polymers. 2.7. Kinetics. 3. *Free radical addition polymerization.*

	3.1. Initiators. 3.2. Chain growth. 3.3. Termination. 3.4. Steady-state kinetics. 3.5. Industrial polymers prepared through free radical polymerization. 3.6. Inhibitors and retarders. 3.7. Free radical transfer. 4. *Ionic polymerization.* 4.1. Anionic polymerization. 4.2. "Living" polymers. 4.3. Cationic polymerization. 5. *Copolymerization* 5.1. General characteristics. 5.2. Random copolymers. 5.3. Alternating copolymers. 5.4. Graft copolymers and methods for their synthesis. 5.5. Block copolymers and methods for their synthesis.
Recommended reading	1. A.D. Dondos, "Synthetic Macromolecules", Kostarakis Publications., 2002. 2. G.P. Karayannidis, E.D. Sideridou, "Polymer Chemistry", Ziti Publications, 2006. 3. J.M.G. Cowie, "Polymers: Chemistry & Physics of Modern Materials", Blackie Academic & Professional, 1994. 4. G. Odian, "Principles of Polymerization" John Wiley Inc., 1991. 5. C.E. Carraher, "Seymour/Carraher's "Polymer Chemistry", 6th Edition, Marcel Dekker Inc., 2003.
Teaching and learning methods	Lectures and problem-solving seminars for the synthesis of polymers and their precursors.
Assessment and grading methods	Write examination
Language of instruction	Greek

Chemical Industries (Inorganic and Organic)

Course title	Chemical Industries (Inorganic and Organic)
Course code	**XE884**
Type of course	Optional (Chemistry course)
Level of course	Undergraduate
Year of study	4th
Semester	8th
ECTS credits	5
Name of lecturer(s)	Assoc. Prof. G. Bokias, Assist. Prof. Ch. Papadopoulou
Learning outcomes	The aim of this course that the student will be able to: 1. Present the processes for the industrial production of the most important inorganic and organic chemical products, giving special attention to the Greek chemical industry. 2. Understand the thermodynamics and kinetics of the essential steps involved in the production of important inorganic and organic products and to recognise their

	importance for the design of the respective industrial process. 3. Define related common concept like: petroleum, fossil fuels, hydrocarbons, octane number, feed, heat exchanger, etc. 4. Describe basic parts of the structure of an industrial chemical unit, e.g. a specific process of a petroleum distillation unit. 5. Describe the chemical processes needed for a desired product to be produced from a specific raw material used as feed. 6. Evaluate the essential technological, environmental and financial aspects for the design of important chemical industries.
Competences	At the end of the course the student must have developed the following skills/competences: 1. Find information he/she needs from a book on Industrial Chemistry. 2. Recognize and name different parts of a chemical industry unit and describe their function, i.e. 'read' and describe a schematic representation of a chemical industrial unit. 3. Find the appropriate process for the production of a desired product from a feed of given properties. 4. Ability to transfer and to apply fundamental knowledge τo the solution of qualitative and quantitative problems in various steps of industrial processes. 5. Ability to adopt and apply such knowledge and understanding to similar industrial processes. 6. Extract the kinetic equation for a catalytic process, based on data and assumptions. 7. Study skills needed for continuing professional development. 8. Ability to interact with others on inter or multidisciplinary problems.
Prerequisites	It is however recommended that students should have at least a basic knowledge of General Chemistry, Physical processes, Chemical Technology and Catalysis.
Course contents	1. Purification treatment of water as a primary material for industrial chemistry 2. Industries of nitrogen and nitrogen compounds. Ammonia, nitric acid, nitrogen-containing fertilizers. 3. Phosphorus-containing fertilizers. 4. Sulfur and sulfuric acid. Industrial production of sulfuric acid using the contact process. 5. Hydrochloric acid and halogens. 6. Sodium carbonate and sodium hydroxide. 7. Electrolysis processes. Aluminum and manganese. 8. Portland cement. 9. Iron and steel. 10. Row materials for Organic Chemistry. 11. Natural gas and petroleum: historical background of the discovery and uses of fossil hydrocarbons, origin, physical and chemical properties. 12. Refining and uses of natural gas. 13. Structure of crude petroleum refinery, flow diagram. 14. Analytic methods applied to define the composition and the quality of crude petroleum. 15. Atmospheric and vacuum distillation, products and their uses. 16. Catalytic reforming of naphtha, products and their uses. 17. Catalytic isomerizations, products and their uses. 18. Hydrorefining. 19. Cracking processes, products and their uses.

	20. Methane, ethylene, propylene, butanes, benzene, toluene and xylenes as raw materials of petrochemichals. Every process is focused on the characteristics of the feed, the properties of the product, the types of the chemical reactors and the reaction conditions, the catalytic materials and their function, the schematic representation of the industrial process.
Recommended reading	1. A. Lycourghiotis, Ch. Kordulis, "Catalytic processes of Organic Industries", Publications of University of Patras. 2. Royal Dutch Shell Group of Companies, Koninklijke Nederlandsche, Petroleum Maatschappij, "The Petroleum Handbook", 6th Edition, Elsevier, 1986. 3. H.A. Wittcoff, B.G. Reuben, "Industrial Organic Chemicals in perspective", J. Wiley-Interscience, 1980. 4. F. Pomonis, "Organic Chemical Technology", Publications of University of Ioannina. 5. Kallitsis, N. Kalfoglou, "Basic principles of inorganic chemical industries", Publications of University of Patras. 6. Sdoukos, F. Pomonis, "Inorganic Chemical technology", Tziolas Publications, 2010. 7. I. Chatiris, N. Kalkanis, "Chemical technology", S. Parikou Publications, 1998.
Teaching and learning methods	Lectures using power-point presentations. The students have active participation, e.g. based on given information they are asked to identify the next step in a certain industrial process. Using of process flow diagrams and obtaining the information they contain.
Assessment and grading methods	1. Evaluation of the student's progress throughout the whole semester by written tests in every chapter. If they succeed to all of them (mark ≥ 5 for each test) this may be their final mark. 2. Writtenexamination at the end of the semester. Exams in both cases comprise questions of various types: multiple choice, right/ wrong, correlations, filling the gaps, extracting kinetic equations, etc. Greek grading scale: 1 to 10. Minimum passing grade: 5. Grades ≤3 correspond to ECTS grade F. Grade 4 corresponds to ECTS grade FX. For the passing grades the following correspondence normally holds: 5 ↔ E, 6 ↔ D, 7 ↔ C, 8 ↔ B and ≥9 ↔ A.
Language of instruction	Greek

Food Chemistry and Technology – Oenology II

Course title	Food Chemistry and Technology – Oenology II
Course code	**XE872**
Type of course	Optional (Chemistry course)
Level of course	Undergraduate
Year of study	4th
Semester	8th
ECTS credits	5
Name of lecturer(s)	Prof. M. Kanellaki, Assist. Prof. A. Bekatorou
Learning outcomes	At the end of the course the student will have acquired the necessary knowledge on: 1. All the factors (microbiological, environmental, etc.) that affect food spoilage. 2. The ways of food preservation at at industrial, trade or household scale. 3. The effects of food spoilage on human health. 4. The biochemistry of wine making.

	5. The nutritional value of genetically engineered food and probiotic food. 6. Food legislation.
Competences	At the end of the course the student will have further developed the following skills/competences: 1. Ability to know and apply the optimum conditions for food preservation and storage, and to easily recognize spoiled food such as meat, milk, cheese, etc. 2. Ability to intervene and modify the course of fermentation when correctional action is needed, exploiting the knowledge obtained on wine making biochemistry. 3. Ability to seek employment in food industries, small scale enterprises and laboratories, or to develop new food related enterprises, exploiting the knowledge obtained on food microbiology and food legislation.
Prerequisites	There are no prerequisite courses. It is however recommended that students should have at least a basic knowledge of Organic Chemistry, Biochemistry and Chemical Technology.
Course contents	*A. Food spoilage and preservation - Oenology* 1. Food microbiology. Bacteria (morphology, physiology, classification). Environmental factors that affect bacterial growth. Fungi (morphology, physiology, classification). Environmental factors that affect fungal growth and metabolic activity. 2. Foods poilage. Causes. Spoilage of the main food constituents (carbohydrates, proteins, fats and oils, vitamins, natural pigments). Spoilage of specific food groups (fruit and vegetables, meat, milk, cereals and their products). 3. Food preservation. Thermal preservation. Drying of various food products fruit and vegetables, animal products, beverages and condiments). Preservation by condensation. Preservation by salting and curing. Preservation by smoking (smoked food). Preservation by canning and bottling. Preservation by freezing. Preservation by chemical additives. Preservation by irradiation. Packaging materials. Food legislation. 4. Oenology–Wine microbiology. Yeast morphology, physiology, composition, and nutritional requirements. Microorganisms related with alcoholic fermentation: *Candida, Saccharomyces, Torulopsis*. *Saccharomyces* species: *S. cerevisiae, S. elipsoides, S. apiculatus, S. pombe, S. bayanus, S. pastorianus*. Sugars in alcoholic fermentation. Biochemistry of alcoholic fermentation. Wine spoilage microorganisms. Control of grape must fermentation. Factors that affect yeast viability and wine spoilage. Causes and cure of stuck fermentations. Malolactic fermentation. Yeast isolation. Liquid and solid yeast cultures. Preparation of liquid culture in grape must for the promotion of wine fermentation. The role of oxygen in alcoholic fermentation. Redox potential of wine. Redox constituents of wine. Baker's yeast and fodder yeast production. Other microorganisms in alcoholic fermentation: the bacterium *Zymomonas mobilis*. *B. Nutritional value of genetically modified food.* *C. Probiotic food.* *D. Food legislation-chemical additives in food.* *E. Two-month practical training*, which will be supervised by the academic staff, in a winery, alcohol distillery, liquor production enterprise, brewery, or baker's yeast production plant.
Recommended reading	1. A. A. Koutinas, M. Kanellaki,"Food Chemistry and Technology",Publications of University of Patras, 2010. 2. J. Jay, "Modern Food Microbiology", 6th Edition, Springer-Verlag, 2000. 3. H.-D. Belitz, W. Grosch, P. Schieberle, "Food Chemistry", 3rdrevised edition, Editor: S. Rafailidis, Translation: M.D. Papageorgiou, A.I. Varnalis, Tziolas Publications, 2007. 4. O.R. Fennema, "Food Chemistry", 3rd Edition, Marcel Dekker Inc., 1996. 5. R.S. Jackson "Wine Science: Principles and Applications", 3rd Edition, Elsevier, 2008.
Teaching and	• Power point presentations.

learning methods	• Visits to food industries/enterprises.
Assessment and grading methods	Final written course examinations
Language of instruction	Greek. Instruction may be given in English if foreign students attend the course.

Renewable Energy Sources and Chemical Storage

Course title	Renewable Energy Sources and Chemical Storage
Course code	**XE893**
Type of course	Optional (Chemistry course)
Level of course	Undergraduate
Year of study	4th
Semester	8th
ECTS credits	5
Name of lecturer(s)	Prof. M. Kanellaki, Assist. Prof. A. Bekatorou, Assist. Prof. Ch. Papadopoulou, Assoc. Prof. Y. Tripanagnostopoulos
Learning outcomes	At the end of this course the student will be able to: 1. Know the various forms of Renewable Energy Sources (RES), such as solar, wind and hydroelectric, biomass, geothermal, as well as spatial dispersion. 2. Know the operation fundamentals of the various RES exploitation systems (solar heat, photovoltaics, wind power, hydroelectric power, biofuels, and geothermal systems). 3. Calculate the available potential of each energy source. 4. Calculate the yield factors of the various RES exploitation systems.
Competences	At the end of the course the student will have further developed the following skills/competences: 1. Ability to demonstrate knowledge and understanding of essential data, concepts, principles, and theories related to the exploitation of energy sources. 2. Ability to apply this knowledge and understanding to solve qualitative and quantitative problems. 3. Ability to adopt and apply methodologies in problem solution.
Prerequisites	There are no prerequisite courses. It is however recommended that students should have at least a basic knowledge of Physical Chemistry
Course contents	1. Development of methods for physicochemical energy storage. 2. Chemical reactions of energy storage – Chemical heat pumps. 3. Biofuels: Raw materials, enzymes, microorganisms, and traditional technology in bioethanol production. 4. Biofuels: New trends in bioethanol production – bioreactors. 5. Biofuels: Production of Bioethanol from sugar beet and straw – Biogas. 6. Introduction: Renewable sources, potential and methods of exploitation. 7. Thermal solar systems. 8. Photovoltaics. 9. Biodiesel: Raw materials and methods of production. 10. Biohydrogen: Biological methods of production – Microbial fuel cells. 11. Production, storage and conversion of hydrogen to electric energy I. 12. Production, storage and conversion of hydrogen to electric energy II.
Recommended	1. P. Giannoulis, A.A. Koutinas, "Renewable Sources and Chemical Storage of

reading	Energy”, Publications of University of Patras. 2. P. Giannoulis, “New sources of energy”, Publications of University of Patras, 2009. 3. J.A. Duffie, W.A. Beckman,“Solar Engineering of Thermal Processes”, 3rd Edition, Wiley, 2006. 4. J. Twidell, T. Weir,“Renewable Energy Resources”, 2nd Edition, Taylor & Francis, 2006. 5. J.F. Kreider, F. Kreith (editors),“Solar Energy Handbook”, McGraw Hill Series in Modern Structures, McGraw Hill, 1981.
Teaching and learning methods	Lectures using slides for overhead projector and power-point presentations.
Assessment and grading methods	Final written course examination.
Language of instruction	Greek. Instruction may be given in English if foreign students attend the course.

V. POSTGRADUATE STUDIES

The PhD Diploma offered by the Department of Chemistry is described as: "PhD in Chemistry". The Program of Post Graduate Studies of the Deprtment of Chemistry of the University of Patras was established in 1993 and is active since 1994. Since 2010, the Program has been reorganised and updated, following the recent European and international standards. The PostGraduate Program enrols graduates from all Departments of the Schools of Sciences and Polytechnic Institutions of the Country or corresponding Departments abroad.

A three-member committee (one main supervisor and two-co-supervisors) is assigned for every PhD canditate. The average time required for the doctorate Diploma is three years. An MSc Diploma is a prerequisite for the application for a PhD Diploma. During the first year of the doctorate studies, the student is obliged to follow four courses (two courses each semester) and pass the associated exams. These courses are proposed by the three-member advisory committee, and may be the same as those of the previous MSc program of the PhD candidate. The list of courses for the doctorate studies includes all courses of the approved interdepartmental and international Post-Graduate Programs of the Department of Chemistry, as well as courses that have been proposed by the Departmental Sectors. The minimum passing grade is 5 out of 10. The exams take place at the end of each semester and repeat exams take place in September. No specific requirements for admission and registration apply to the ERASMUS students. Specifically, the PostGraduate Studies Program of the Department of Chemistry offers the following:

V.1 Master of Science (MSc) specialisasions

1. ***Applied Biochemistry: Clinical Chemistry, Biotechnology and Evaluation of Pharmaceutical Products***
2. ***Synthetic Chemistry and Advanced Polymeric and Nanostructured Materials***
3. ***Catalysis, Pollution Control and Clean Energy Production***
4. ***Analytical Chemistry and Nanotechnology***
5. ***Green Chemistry and Clean Technologies***

Each specialization is coordinated by a faculty member of the Department. The current coordinators are:

1. *Applied Biochemistry: Clinical Chemistry, Biotechnology and Evaluation of Pharmaceutical Products*	**Prof. Dimitrios Vynios**
2. *Synthetic Chemistry and Advanced Polymeric and Nanostructured Materials*	**Assoc. Prof. Georgios Bokias**
3. *Catalysis, Pollution Control and Clean Energy Production*	**Prof. Christos Kordulis**
4. *Analytical Chemistry and Nanotechnology*	**Prof. Thoedore Christopoulos**
5. *Green Chemistry and Clean Technologies*	**Assist. Prof. Charalambos Matralis**

✓ *The Director of the PostGraduate Studies Program for the period 2017-2018 is Prof. D. Vynios.*

V.2 The Doctor of Philosophy Diploma (PhD)

The PhD diploma covers all research activities of the Department of Chemistry. The Program of PostGraduate Studies enrols graduates from all Departments of the Schools of Sciences and Polytechnic Institutions of the Country or corresponding Departments abroad.

V.2.1 Regulations for the PhD Diploma

Under the current institutional framework of postgraduate studies, as described in Law 3685/15.07.2008 and the decisions no. 13/05.11.2008, 9/03.07.2009, 4/26.03.2010, 8/24.04.2012 and 4/13.05.2015 of the General Assembly of the Department of Chemistry (GADC), the Regulations for the PhD Diploma at the Department of Chemistry are configured as shown below, with effect from the Academic year 2015-16.

Article 1: Structure and operating rules

The proper functioning of the Program is controlled directly by the GADC of the Department. The duration of studies for the PhD Diploma is at least three years from the date of appointment of the three-member advisory committee. Especially for doctoral candidates, non-owners of a MSc, falling into the category of exceptional cases (Law 3685/2008, article 9, paragraph 1b), the period of doctorate studies is set at four years at least, under the current legal regime.

Article 2: Select admitted to a course for PhD

Applicants for a PhD Diploma must be holders of an MSc Diploma. The application can be submitted at any date and discussed at the next meeting of the GADC of the Department. The applicants should contact previously a faculty member of the Department, which will agree to be appointed as supervisor of the doctorate thesis and endorse the request. In exceptional cases, namely graduates with bachelor (*ptychion*) degree of 8.5 or more (Excellent) can be admitted as doctoral candidates without holding an MSc. These applications are also examined by the GADC of the Department. Graduates of Schools equivalent to Universities can be admitted as doctoral candidates only if they are holders of a MSc.

Article 3: Initial registration - Renewing registrations

The initial registration of doctoral candidates will be made within twenty days from the date of their selection or within the dates determined by the Department. For reasons of exceptional necessity registration may be done within a month after deadline, after reasoned request from the candidate and decision of the GADC. The PhD students are required to renew their registration. The renewal is done by request within deadlines set by the GADC. Renewing of registrations will be made once in a year at the beginning of each academic year. A PhD student, who did not renew the registration and did not attend or conduct research for two consecutive semesters, ceases to be enrolled in the doctorate program. Suspension of studies is possible for a given period, which may not exceed twelve months, based on serious grounds and following a decision of the GADC taken after request of the PhD candidate. During the study suspension any benefits are removed, which are recovered following a new request of the interested candidate. The status of PhD candidate is incompatible with the provision of any form of teaching/educational work relative to the courses of the Curriculum of the Department of Chemistry of the University of Patras, if it is outside of his/her obligations within the Department. The PhD students, when registering in the PhD program will ensure with solemn declaration of compliance with this paragraph. The relative affidavit will be submitted by each PhD student to the Secretariat of the Department upon registration.

Article 4: Academic Calendar

Teaching and examinations of the Autumn semester are conducted from the 3rd week of October to the end of February (18 training weeks), and of the Spring semester from early March until the 3rd week of July (18 training weeks). At the end of each semester, the examinations of the corresponding courses take place. The examination period may not exceed one week. The time course and exam schedule of each semester is announced at least ten days before the semester starts. For the examinations, the same rules apply as for the undergraduate students.

Article 5: Attendance of Courses - Grading

The attendance of teaching courses and exercises (laboratory, tutorial) is mandatory. The courses are taught in Greek, but also in English if necessary. The teaching of the course and conduct of exercises or seminars, where applicable, is delegated by the GADC as defined in Article 5 par. 1 and 3 of Law 3685/2008. If there are extremely serious and substantiated reasons of the PhD candidates to fail attend the courses and participate in the planned program of exercises, absence may be justified, the maximum duration of which cannot exceed 1/6 of the courses or exercises performed. The performance in each subject is assessed by the instructor(s) according the existing grading scale (as for undergraduates). In case that the duration of absence exceeds the defined limit, the PhD student is obliged to repeat the course. If a PhD student fails in a course, he/she is obliged to attend the course in a subsequent semester. In case of a second failure, the PhD student is removed from the program following a decision of the GADC. The grades are sent to the Secretariat of the Department of Chemistry within twenty days after the end of the examination period. In the transcripts, provided by the Secretariat of the Department, all passing grades are found.

The PhD students are obliged to provide four hours per week auxiliary educational work in laboratory or tutorial education of undergraduate or postgraduate students of the Department, for at least two semesters (in any semester of their program). They also have the obligation, upon request, to provide other educational services, such as participation in surveillance examinations within the first three years. Doctoral candidates, who prepare the main experimental part of their doctoral thesis at an institution outside the University of Patras, will not be counted in the allocation of money to purchase consumables and will not have the obligation to provide auxiliary and educational work.

Article 6: Appointment of supervisor committees

The supervisor and the three-member Advisory Committee on the supervision and guidance of the candidate are designated in accordance with Article 9 paragraphs 2 and 3 of Law 3685/2008. The proposal for the establishment of the three-member advisory committee is in the responsibility of the supervisor. The final decision is obtained by the GADC of the Department. The three-member advisory committee in collaboration with the doctoral candidate proposes the topic of the doctoral thesis that must be defined in the next GADC and within two months of registration of the doctoral candidate in the PhD Diploma Program.

The three-member committee comprises a Professor of the Department, as Supervisor, and two other members, Professors or Lecturers of the same or another Department of the same University or other domestic or foreign, retired university professors due to age limit, Technological Institutions Professors or researchers of grades A, B or C of recognized research institutes, Greek or international, being PhD holders. Committee members should be of the same or similar academic field in which the PhD candidate works. PhD students, in collaboration with the three-member Advisory Committee, submit a progress report to the GADC the Department at the end of each year from its definition. The GADC in no. 6/6.26.2013 meeting to facilitate preparation of annual progress reports, as provided for by Law 3685/2008, established a blueprint as a model, which is at Appendix I of the Regulations.

The PhD students present a 30-min seminar, connected to each progress report. The summary of the seminar will be announced by the supervisor and posted on the Department's website at least five (5) days before the presentation. PhD students, after the deposit of the three-member advisory committee document to start writing of the PhD Thesis, are not obliged in seminar presentation. The members of the advisory committee should have active research activity.

Article 7: Evaluation and review of doctoral candidates

For the final assessment of the Phd Thesis of the doctoral candidate, following completion of his/her obligations, a seven-member examining committee is defined by the GADC, on a proposal from the three-member Advisory Committee, which brings together the members of the advisory committee. Four (4) at least members of the examining committee must be Professors or Lecturers, of which at least two (2) belong to the relevant department. The other members of the Committee may be Professors or Lecturers of Universities in Greece or from an Institution abroad, retired university professors due to age limit, Technological Institutions Professors or researchers of grades A, B or C of recognized research institutes, Greek or international, being PhD holders. At least one member of the examining committee must not belong to the Chemistry Department, according to the Decision 13/11.5.08 of GADC. All members of the examining committee should be of the same or similar academic field in which the PhD candidate completed his dissertation. The members of the examining committee should have active research activity within the last five years, which is established under the responsibility of the advisory committee.The examining Committee defines the date, time and place of the public support of the PhD thesis. This decision of the committee communicated to the PhD candidate and the Department at least five days before the date of the public support of the thesis.

The PhD student presents his thesis, in public, before the seven-member examining committee, which then considers the originality of the thesis and whether this is a contribution to science. For the approval of the doctoral thesis, assent is required of at least five (5) members of the examining committee. The doctoral thesis should have new results, not recorded in the MSc thesis. Thus, the MSc thesis together with the PhD thesis will be filed to the seven-member examining committee, to check the originality of PhD Thesis. Any text, figure or table of another scientific report requires a bibliographical reference. For approval of the PhD thesis, the minimum required is either one publication in a scientific journal or presentation by the candidate of one oral or poster work at an international conference, or interest in a patent application, which will be demonstrated by the submission of necessary data. The final nomination of the candidate to doctorate is made by GADC when he/she completes with his/her obligations stemming from his/her doctoral studies and fulfills these requirements, which will be certified by a written confirmation of the advisory committee, which will accompany the record of decision.

For the nomination are required: i) four plasticized or leather bound copies of the text of doctoral thesis (with final adjustments), ii) the record of decision signed by the members of the examining committee, accompanied by written confirmation of the Advisory Committee (Appendix II),iii) a cd with the final text of doctorate thesis and a cd with summaries in Greek and English, iv) a completed census bulletin of the National Archive of Dissertations of the National Documentation Centre, v) certificate of the Central Library of the University that the thessi is deposited in the repository NEMERTES.

In Conferred doctorates there is no grading or designation. The number of doctoral students supervised by each faculty member cannot exceed five. Doctoral candidates who have completed three years from the announcement of the dissertation topic or from the date of registration in the PhD Diploma courses are not counted.

Article 8: Benefits

Doctoral candidates, who do not have health coverage, are entitled to the student welfare benefits in accordance with the applicable legal framework.

VI. DESCRIPTION OF THE POSTGRADUATE COURCES

VI.1 MSc Diploma

1. Applied Biochemistry: Clinical Chemistry, Biotechnology and Evaluation of Pharmaceutical Products

General Description

The MSc "Applied Biochemistry" includes Clinical Chemistry and Biological Evaluation of Pharmaceutical Products, which are indispensable for the vocational rehabilitation of graduates.

Study Program

First Semester

Biochemical Analysis-Clinical Biochemistry	**10** *ECTS*
Advanced Biochemistry	**10** *ECTS*
Literature Review and Research Methodology	**10** *ECTS*
Total number of credits	**30** *ECTS*

Second Semester

Molecular Pharmacology-Immunology	**10** *ECTS*
Molecular Biology-Molecular Biotechnology	**10** *ECTS*
Launch of Research Activities for MSc Thesis	**10** *ECTS*
Total number of credits	**30** *ECTS*

Third Semester

MSc Thesis: Completion of the research project *Writing and Defense of the Thesis*	**30** *ECTS*
Total number of credits	**30** *ECTS*

Courses

Biochemical Analysis – Clinical Biochemistry

- Liquid chromatography (gel, ion-exchange, affinity). Theory, applications.
- HPLC: Theory, techniques, applications. GC: Applications. SFC: Theory, applications.
- Electrophoresis: Theory and techniques. Capillary electrophoresis: Applications.
- Enzyme in analysis: Chemistry and applications of enzymes, biosensors.
- Radionucleids in analysis.
- Immunoenzymatic analytical methods: Theory, techniques, applications.
- Automatisation in analysis, Modern auto-analyzers,

- Methods selection criteria - Development of analytical methods.
- Selection of methods for the analysis of biological fluids.
- Biochemistry of the main organs and endocrine glands.
- Control of organs and endocrine glands functions.
- Evaluation of results.
- Analysis of metabolites, drugs and toxic substances.

Advanced Biochemistry

- Membranes – signal transduction.
  - cAMP pathway, protein kinase A.
  - cAMP receptors (Epac), activation protein kinase B (Akt).
  - Phosphoinisitide pathway, protein kinase C.
  - Ca^{2+} signalling.
  - Tyrosine kinases, small G proteins, PI-3 kinase.
  - MAP kinases (ERK1,2, JNKs, p38).
  - NO signaling pathways, cGMP, protein kinase G.
  - Transcription factors (CREB, CREM, NF-kB, AP-1, STAT) and their activation.
  - Prostaglandins.
  - Steroid hormones.
  - Signaling pathways of main cytokines and growth factors, IL-1, TNF-α, TGF-β (SMAD proteins), PDGF, EGF, FGF.
- Interaction of ECM and cells.
- Integration of metabolism in prokaryotes and eukaryotes. Control mechanisms of metabolism of carbohydrates, proteins and fats.
- Basic Physiology (nervous system, liver, gallbladder, pancreas).

Literature Review and Research Methodology

Molecular Pharmacology - Immunology

- Effect of drugs to enzymes (binding interactions, competitive and non-competitive inhibitors, allosteric inhibitors), the catalytic role of enzymes, enzyme regulation, isoenzymes, pharmaceutical applications of inhibitors (inhibitors for enzymes, microbes, viruses and body enzymes).
- Effect of drug to receptors (the role of receptor, neurotransmitters and hormones, design of agonists and antagonists, partial and reverse agonists, desensitization and sensitization, tolerance and dependence, cytoplasmic receptors, types and subtypes of receptors).
- Structure and functions of nucleic acids (DNA structure, DNA-acting drugs, RNA structure, RNA-acting drugs, drugs related to nucleic acids and their structural units, molecular biology and genetic engineering).
- Adrenergic nervous system (adrenergic system, adrenergic receptors and transducers, biosynthesis and metabolism of cateholamines, neurotransmission, drug targets, adrenergic site of binding, structure – biological activity relations, adrenergic agonists, antagonists of agrenergic receptor, drugs acting to adrenergic transduction).
- Opium-related analgetics (morphine, morphine analogues development, analgetic receptors, agonists and antagonists, encephalines and endorphines, receptors mechanisms)
- Innate immunity-Complement.
- Acquired immunity (humoral immunity, cellular immunity).
  - Antibodies, antibodies classes, structure, production (B-lymphocytes, clone selection theory),

immune system memory, vaccines, monoclonal antibody production, antibodies biosynthesis.

- Immunogens, antigens, antigen determinants, epitopes.
- Antigen-antibody complex. Antigen presenting cells.
- Proteins of the major innumohistocompatibility complex (MHC-I, MHC-II).
- T-lymphocytes (Th1 and Th2 help cells, cytotoxic Tc cells), T-cells receptors.
- MHC-I / Tc and MHC-II / Th complexes.
- Biosynthesis of T-cells receptors and MHC proteins.

Molecular Biology – Molecular Biotechnology

- DNA organisation.
- Annealing and hybridisation.
- Eukaryotic genome transcription and translation.
- DNA mapping.
- Gene structure and function.
- DNA replication in viruses, eukaryotic and prokaryotic cells.
- Strain selection, genetic recombination.
- Protoplasts fusion, techniques for isolation of DNA sequences (restriction enzymes).
- cDNA, gene libraries.
- DNA vectors (plasmids, cosmids, phages).
- Cloning vectors, sequences vectors, expression vectors.
- Methods of integration, transport and recombination of genetic information.
- Analysis and isolation of recombinant clones.
- Cloning systems and applications in Biotechnology.
- Enzymes technology (immobilization of enzymes, kinetics of immobilized enzymes, reactions and kinetics in biphasic systems, reverse enzyme reactions, artificial enzymes).
- Industrial applications (Manufacture of dairy products, alcoholic beverages, fruit juices, single-cell protein, industrial fermentations: alcohol, organic acids and aminoacids, pharmaceuticals, baking, syrups, processing of wastes: biofertilizers, methane).

Launch of Research Activities for MScThesis

Faculty members

The MSc program is supported mainly by the following faculty members of the Department of Chemistry: A. Aletras, A. Theocharis, N. Karamanos, Th. Tsegenidis, D. Vynios, S. Skandalis.

2. Synthetic Chemistry and Advanced Polymeric and Nanostructured Materials

General Description

Education and training on the design and techniques necessary for the synthesis, purification and identification/characterization of a wide range of synthetic chemical products (organic, inorganic, organometallic, nanomaterials). Such training offers a solid background for the design of functional polymeric and nanostructured materials for advanced applications with technological/biological/medical interest.

Study Program

First Semester

Synthetic Organic, Inorganic and Organometallic Chemistry	***10** ECTS*
Synthesis of Advanced Polymeric and Nanostructured Materials	***10** ECTS*
Literature Review and Research Methodology	***10** ECTS*
Total number of credits	***30** ECTS*

Second Semester

Techniques for the Identification and Characterization of Synthetic Products and Materials	***10** ECTS*
Properties and Applications of Functional and Nanostructured Materials	***10** ECTS*
Launch of Research Activities for MSc Thesis	***10** ECTS*
Total number of credits	***30** ECTS*

Third Semester

MSc Thesis: Completion of the research project *Writing and Defense of the Thesis*	***30** ECTS*
Total number of credits	***30** ECTS*

Courses

Synthetic Organic, Inorganic and Organometallic Chemistry

- Synthesis of Carbon Chains.
- Synthesis of Carbocyclic Compounds.
- Functional Group Interconversions.
- Synthesis of Heterocycles and Arenes.
- Antithetic Analysis – Synthetic Schemes.
- Synthesis of Coordination Compounds
- Organic Chemistry of Metal Complexes
- Synthetic Approaches in the Chemistry of Homo- and Heterometallic Polynuclear Complexes
- Syntheses of Coordination Polymers and Metal-Organic Frameworks (MOFs) - The Modular Approach
- Hydro(Solvo)thermal Methods in Inorganic Chemistry
- Microwave-Assisted Inorganic Syntheses

- Chemistry of Organometallic Compounds

Synthesis of Advanced Polymeric and Nanostructured Materials

- Advanced polymer synthesis
- Macromolecular engineering
- Synthesis of functional polymeric materials (conducting-semiconducting polymers)
- Synthesis of nanosized materials and of supramolecular systems – Fullerene chemistry
- Chemical modification of advanced materials (dendrimers, nanotubes, graphene)
- Synthesis of inorganic and organic/inorganic nanoparticles and nanostructured materials (metal nanoparticles, quantum dots, magnetic nanoparticles, ordered silica, clays)

Literature Review and Research Methodology

Techniques for the Identification and Characterization of Synthetic Products and Materials

- High performance liquid chromatography (HPLC): Organology, principles and applications.
- Supercritical fluid Chromatography (SFC): principles and applications.
- Size Exclusion Chromatography (SEC).
- Field flow fractionation (FFF)
- Gas Chromatography (GC)
- Advanced IR and UV Spectrosopies
- Raman Spectroscopy
- Advanced NMR Spectroscopy
- Electron Paramagnetic Resonance Spectroscopy
- Advanced Mass Spectrometry (MS)
- Electronic Spectroscopy (Ligand-Field Approach) of Transition Metal Complexes
- Techniques for the determination of molecular weights (GPC, scattering techniques, VPO)
- Single-crystal X-ray Crystallography
- Magnetochemistry
- Thermal properties and thermal analysis.
- Mechanical Properties of materials.
- Atomic Force Microscopy (AFM)
- Scanning and Transmission Electron Microspopies (SEM, TEM)
- Spectroscopies of Diffused Reflection (UV-Vis-NIR, FTIR)
- Photoelectron Spectroscopy of X-Rays (XPS)
- Photoelectron Spectroscopy Auger (AES)
- Ion Scattering Spectroscopy (ISS)
- Secondary Ion Mass Spectrometry (SIMS)
- Fine Structure Absorption Spectroscopy of X-Rays (EXAFS)
- Powder X-Ray Diffraction (XRD)
- X-Ray Fluorescence (XRF)
- Thermochemical Methods (TPR, TPO, etc)
- Methods of the Determination of Surface Acidity (PT, PMT, IT, etc)

Properties and Applications of Functional and Nanostructured Materials

- Colloids
- Functional/responsive polymers and hydrogels
- Applications of semiconductive polymers
- Polymers for energy applications – polymeric membranes
- (Single)molecular magnets
- Applications of inorganic and hybrid nanostructured materials
- Degradable polymers

Launch of Research Activities for MSc Thesis

Faculty members

The specialization is mainly supported by the following faculty members: C. Athanassopoulos, G. Bokias, E. Dalas, Ch. Deimede, D. Gatos, P. Ioannou, J. Kallitsis, G. Karaiskakis, N. Klouras, A. Koliadima, Ch. Kordulis, V. Nastopoulos, Ch. Papadopoulou, D. Papaioannou, S. Perlepes, C. Poulos, G. Rassias, G. Spyroulias, Th. Tsegenidis, Th. Tselios, G. Tsivgoulis, C. Tsitsilianis.

3. Catalysis, Pollution control and Clean Energy Production

General Description

The program aims to familiarize the graduates with the development and use of catalytic, sorption, and biological processes for protecting the environment through pollutants destruction, the development of green catalytic processes and the production of bio-fuels and hydrogen.

The graduates of this program will be able to:

1. Select the most suitable pollution control process for a certain case.
2. Select the most suitable process for liquid fuels and hydrogen production from the available renewable sources (e.g. Biomass, water).
3. Select and/or develop suitable catalysts for destruction of pollutants and production of bio-fuels and hydrogen.
4. Characterize and evaluate solid catalysts by the joint use of modern physicochemical methods.

Study Program

First Semester

Development, Characterization and Evaluation of Solid Catalysts	***10** ECTS*
Air Pollution Control	***10** ECTS*
Bibliographic Review and Research Activities for MSc Thesis	***10** ECTS*
Total number of credits	***30** ECTS*

Second Semester

Water and Soil Pollution Control	***10** ECTS*
Bio-fuels Production	***10** ECTS*
Launch of Research Activities for MSc Thesis	***10** ECTS*
Total number of credits	***30** ECTS*

Third Semester

MSc Thesis: Completion of the research project *Writing and Defense of the Thesis*	***30** ECTS*
Total number of credits	***30** ECTS*

Courses

Development, Characterization and Evaluation of Solid Catalysts

- Design of solid catalysts.
- Solid catalysts preparation methods (precipitation/gelation, co-precipitation/co-gelation, co-precipitation/co-gelation in the presence of templates, incipient wetness impregnation, wet impregnation, deposition precipitation, equilibrium-deposition-filtration, chemical vapor deposition, grafting…).
- Methods of solid catalysts characterization (texture determination, ICP-MS, ICP-AES, FTIR, DRFT, LRS, UV-Vis DRS, XPS, AES, ISS, SIMS, Solid State NMR, SEM, TEM…).
- Evaluation of solid catalysts using laboratory reactors.

Air Pollution Control

- Gaseous pollutants.
- Catalytic processes for pollution control.
- Catalytic processes for production of conventional fuels friendly to the environment.

Literature Review and Research Methodology

Water and Soil Pollution Control

- Waste water characteristics.
- Waste water treatment (physical, chemical, biological).
- Advanced methods for water and waste water treatment (sorption, bio-sorption, ion-exchange, photocatalytic treatment, pollutants destruction using ultrasounds …).
- Waste water exploitation (recovering of useful substances, fermentation, composting, reuse…).
- Pollution monitoring and remediation in the soil and the sediments.

Bio-fuels Production

- First generation bio-fuels.
- Second generation bio-fuels.
- Future bio-fuels.
- Hydrogen (production, storage, transportation, exploitation…).

Launch of Research Activities for MSc Thesis

Faculty members

The specialization is mainly supported by the following faculty members:

A. Lycourghiotis, Ch. Kordulis, Ch. Papadopoulou, Ch. Matralis, H. Karapanagioti, H. Papaefthymiou, B. Symeopoulos, M. Soupioni.

4. Analytical Chemistry and Nanotechnology

General Description

This program is designed to provide broad training in modern analytical techniques and their wide-ranging applications to biomedical, pharmaceutical, environmental, food, and materials analysis. Emphasis is given to the impact of nanotechnology on the development of novel analytical methods and sensing devices, as well as to those techniques that play an important role in the investigation of the morphology, composition and structure at the micro- and nanoscale.

Study Program

First Semester

Micro/Nanotechnology - Chemical Sensors	***10*** *ECTS*
Investigating the Micro- and Nanoworld: Microscopy	***10*** *ECTS*
Literature Review and Research Methods	***10*** *ECTS*
Total number of credits	***30*** *ECTS*

Second Semester

Investigating the Micro- and Nanoworld: Spectroscopy	***10*** *ECTS*
Separation Science	***10*** *ECTS*
Launch of Research Activities for MSc Thesis	***10*** *ECTS*
Total number of credits	***30*** *ECTS*

Third Semester

MSc Thesis: Completion of the research project *Writing and Defense of the Thesis*	***30*** *ECTS*
Total number of credits	***30*** *ECTS*

Courses

Micro/Nanotechnology - Chemical Sensors

Design and construction of analytical chips. Microfluidic devices. Detectors. Microarray technology. Exploiting the new properties of the nanoparticles (electrical, optical and magnetic) for the development of novel analytical methods and devices. Chemical modification and conjugation of nanoparticles. Principles of sensor development. Optical, electrochemical and mass sensors.

Investigating the Micro- and Nanoworld: Microscopy

Transmission electron microscopy (TEM). Scanning electron microscopy (SEM). Focused ion beam (FIB). Analytical electron microscopy (AEM). Electron energy-loss spectroscopy (EELS). Energy-dispersive X-ray spectroscopy (EDS). Wavelength-dispersive X-ray spectroscopy (WDS). Atomic force microscopy (AFM). Scanning tunneling microscopy (STM). Cathode luminescence spectroscopy and microscopy.

Literature Review and Research Methodology

Investigating the Micro- and Nanoworld: Spectroscopy

Structural analysis. X-ray diffraction. Data bases for mining structural information. Mass spectrometry.Raman spectroscopy.Auger electron spectroscopy (AES). X-ray photoelectron spectroscopy (XPS)

Separation Science

Physicochemical approach of the chromatographic techniques.Gas chromatography.Liquid chromatography.High performance liquid chromatography (HPLC).Comparison between liquid and gas chromatography.One-phase chromatography (Field-Flow Fractionation).Comparison between Field-Flow Fractionation and conventional chromatographic techniques.Capillary electrophoresis.

Launch of Research Activities for MSc Thesis

Faculty members

The specialization is mainly supported by the following faculty members:

Th. Christopoulos, G. Karaiskakis, V. Nastopoulos, Ch. Papadopoulou, A. Koliadima, C. Athanassopoulos, D. Kalogianni.

5. Green Chemistry and Cleen Technologies

General Description

The program aims are the education and training of graduates in the philosophy and the tools of Green Chemistry and their application in the design of environmentally friendly products and processes, using clean technologies, for sustainability.

Study Program

First Semester

Green Chemistry and Catalysis in Green Chemistry	***10** ECTS*
The environmental impact of chemical processes and alternative solvents	***10** ECTS*
Literature Review and Research Methodology	***10** ECTS*
Total number of credits	***30** ECTS*

Second Semester

Chemicals and Energy from Renewable Feedstock's	***10** ECTS*
Energy Efficiency, New Technologies and Industrial Ecology	***10** ECTS*
Launch of Research Activities for MSc Thesis	***10** ECTS*
Total number of credits	***30** ECTS*

Third Semester

MSc Thesis: Completion of the research project *Writing and Defense of the Thesis*	***30** ECTS*
Total number of credits	***30** ECTS*

Courses

Green Chemistry and Catalysis in Green Chemistry

- The cost of wastes and the changes in chemical industry.
- Green Chemistry: Definition, philosophy and tools.
- The 12 Principles of Green Chemistry.
- Green Chemistry metrics.
- Clean technologies that green chemistry offers.
- Design of products and processes for sustainability, legislation.
- Life Cycle Assessment. Measurement of the greenness of processes and of products.
- Catalysis in Green Chemistry.
- Introduction to the catalysis in green chemistry.
- Heterogeneous acidic catalysis in industry.
- Structured mesoporous materials as green catalysts.
- Biocatalysts.
- EnvirirocatsTM, the case of industrial green catalysts.

The environmental impact of chemical processes and alternative solvents

- Pollutants and processes for immediate solutions through green chemistry.

- Legislation for new chemicals.
- Environmental management of several systems.
- Control and following of wastes.
- Techniques for minimization of wastes.
- Recycling, reuse and recovery for wastes.
- Ecotoxicology.
- Management of liquid wastes.
- Management of solid wastes.
- Methods of thermal treatment of wastes.
- Biological methods for treatment of wastes.
- Alternative solvents for chemical reactions and processes (ionic liquids, water and supercritical fluids).

Literature Review and Research Methodology

Chemicals and Energy from Renewable Feedstock's

- Renewables: Advantages and disadvantages.
- Biomass: Properties, chemical composition, financial factors.
- Biorefinery: technologies and biorefineries of phase I, II and III.
- Biotechnological methods for the production of biofuels.
- Gasification of biomass.
- Pyrolysi of biomass Platforms of chemicals from biomass and their applications.

Energy Efficiency, New Technologies and Industrial Ecology

- Energy and clean technologies; renewable resources, production of hydrogen.
- Fuel cells.
- Photocatalysis.
- Industrial ecology.

Launch of Research Activities for MSc Thesis

Faculty members

The MSc program is supported by the following members of to Department of Chemistry and the Department of Chemical Engineering of the University of Patras:

C. Poulos, A. Lykourgiotis, G. Rassias, Ch. Kordulis, D. Vynios, Ch. Matralis, Ch. Papadopoulou, G. Bokias, C. Athanassopoulos, X. Verykios, K. Vagenas, D. Mataras, D. Kondaridis, M. Kornaros, I. Koukos, S. Boghosian.

VI.2 PhD Diploma

The courses list for the PhD diploma includes all courses of the five specializations of the MsC Diploma, as well as of other interdepartmental or international Programs of PostGraduate Studies coordinated by the Department of Chemistry. Advanced courses proposed by the three Divisions of the Department are also included.

Course	Teaching Staff	Semester
Biochemical Analysis – Clinical Biochemistry	A. Aletras D. Vynios N. Karamanos Th. Tsegenidis	Autumn
Advanced Biochemistry	A. Aletras N. Karamanos S. Skandalis	Autumn
Molecular Pharmacology - Immunology	A. Aletras N. Karamanos E. Papadimitriou	Spring
Molecular Biology – Molecular Biotechnology	A. Vlamis D. Vynios A. Theocharis N. Karamanos	Spring
Synthetic Organic, Inorganic and Organometallic Chemistry	D. Papaioannou C. Athanassopoulos Th. Tselios G. Rassias S. Perlepes P. Ioannou N. Klouras	Autumn
Synthesis of Advanced Polymeric and Nanostructured Materials	J. Kallitsis G. Bokias	Autumn
Techniques for the Identification and Characterization of Synthetic Products and Materials	C. Tsitsilianis Th. Tsegenidis G. Tsivgoulis G. Voyiatzis G. Spyroulias V. Tangoulis C. Athanassopoulos V. Nastopoulos G. Bokias Ch. Deimede S. Perlepes Ch. Kordulis Ch. Papadopoulou	Spring

Course	Teaching Staff	Semester
	G. Karaiskakis A. Koliadima	
Properties and Applications of Functional and Nanostructured Materials	J. Kallitsis G. Bokias Ch. Deimede S. Perlepes E. Dalas	Spring
Development, Characterization and Evaluation of Solid Catalysts	Ch. Kordulis A. Lycourghiotis Ch Papadopoulou	Autumn
Air Pollution Control	Ch. Matralis H. Papaefthymiou	Autumn
Water and Soil Pollution Control	Ch. Matralis H. Karapanagioti B. Symeopoulos M. Soupioni	Spring
Bio-fuels Production	Ch. Papadopoulou	Spring
Micro/Nanotechnology - Chemical Sensors	Th. Christopoulos	Autumn
Investigating the Micro- and Nanoworld: Microscopy	Ch. Papadopoulou	Autumn
Investigating the Micro- and Nanoworld: Spectroscopy	V. Nastopoulos C. Athanassopoulos Ch. Papadopoulou	Spring
Separation Science	G. Karaiskakis A. Koliadima D. Kalogianni	Spring
Green Chemistry and Catalysis in Green Chemistry	C.Poulos Ch. Matralis	Autumn
The environmental impact of chemical processes and alternative solvents	H. Karapanagioti M. Kornaros S. Bogosian C. Poulos	Autumn
Renewable Sources for Energy and Chemicals Production	C. Poulos Ch. Kordulis M. Kornaros Ch. Papadopoulou	Spring
Energy Efficiency, New Technologies and Industrial Ecology	X. Verykios E.Amanatides D. Kondarides I. Kookos Ch. Deimede	Spring
Synthetic Pharaceutical Chemistry	K. Barlos C. Athanassopoulos	Autumn

Course	Teaching Staff	Semester
Peptide and Combinational Chemistry	K. Barlos D. Gatos	Autumn
NMR Spectroscopy and Molecular Design	J. Matsoukas G. Spiroulias G. Tsivgoulis Th. Tselios	Autumn
Biomolecular Analysis	Ch. Kontogiannis K. Poulas M. Orkoula	Autumn
Pharmaceutical Products-Naturals and Synthetics	F. Lamari V. Magafa G. Pairas M. Fousteris	Autumn
Molecular Pharmacology	G. Panagiotakopoulos	Autumn
Molecular and Cell Immunology	A. Mouzaki	Autumn
Molecular Medicine	A. Papachatzopoulou A. Sgourou E. Stefanou	Autumn
Toxicology	S. Topouzis	Autumn
Synthetic Organic Chemistry	D. Papaioannou C. Athanassopoulos	Autumn
Spectroscopy of Organic Compounds	Th. Tsegenidis G. Tsivgoulis C. Athanassopoulos	Autumn
Organic Chemistry of Biological Processes	D. Papaioannou S. Skandalis	Autumn
Pharmacology - Natural Products	F. Lamari G. Iatrou	Autumn
Molecular Biology	A. Theocharis A. Vlamis Z. Lygerou C. Stathopoulos I. Zarkadis M. Klapa	Autumn
Cellular Biology	N. Karamanos A. Aletras A. Theocharis A. Vlamis Z. Lygerou C. Stathopoulos I. Zarkadis A. Papachatzopoulou P. Katsoris	Autumn

Course	Teaching Staff	Semester
	M. Klapa	
Medicinal Chemistry	S. Nikolaropoulos P. Magriotis G. Pairas M. Fousteris	Autumn
Advanced Synthetic Organic Chemistry	D. Papaioannou G. Rassias	Autumn
Structure and Function of Biomacromolecules – Pharmacology	G. Spyroulias E. Papadimitriou K. Poulas S. Topouzis C. Stathopoulos	Autumn
Discovery, Design and Development of Drugs – Pharmacokinetics	G. Spyroulias S. Nikolaropoulos P. Magriotis G. Pairas M. Fousteris	Spring
Methods of Analysis of Biologically Active Molecules	Th. Tsegenidis N. Kaamanos V. Nastopoulos D. Vynios Ch. Papadopoulou C. Athanassopoulos G. Spyroulias Z. Lygerou S. Taraviras E. Patmanidi	Spring
Chemical Biology	D.Papaioannou N. Karamanos Th. Karamanos G. Rassias D. Kalogianni F. Lamari M. Fousteris C. Stathopoulos	Spring

* *Autumn or Spring semester according to the teaching requirements of the Department.*

POSTGRADUATE PROGRAM
"Medicinal Chemistry: Drug Discovery and Design"

Departments of Chemistry, Pharmacy and Medicine
(Euromaster Label, ECTN Association)

www.medicinalchemistry.gr

General Description

The Master's thesis in Medicinal Chemistry consists of both research and written work. The aim is 1) to carry out novel research on important and hot biomedical projects towards new medicines and methods, 2) to train the student in independent research work, information retrieval skills, the critical assessment of sources and research results, and written communication. An independently produced Master's thesis, demonstrates the student's ability to think scientifically and use the necessary research methods to properly treat the topic of the thesis by applying the knowledge and skills acquired in previous studies. The student also proves that he or she is familiar with the thesis topic and can communicate in the field of chemistry, pharmacy and medicine. The scope of the Master's thesis is an advanced Research in "Medicinal Chemistry" which can be achieved through 45 ECTS-compatible credits, including both research and written work. Students must complete a Master's thesis independently, not in pairs or groups. Each student is assigned a personal supervisor and specific project. Students must agree with the Professor of their laboratory on a thesis topic and supervision arrangements (supervisors/immediate supervisors). The professor will also be one of the three examiners assessing the completed thesis. The students most often conduct their research as members of research group and advice also from the other group members. Oral presentation as seminar is given related to the Master Thesis.

Study Program

First Semester

SPC 100	Synthetic Pharmaceutical Chemistry (semi optional)	**4** ***ECTS***
PCC 101	Peptide and Combinational Chemistry (semi optional)	**4** ***ECTS***
NMD 102	NMR Spectroscopy and Molecular Design (semi optional)	**4** ***ECTS***
BAN 103	Biomolecular Analysis (semi optional)	**4** ***ECTS***
PPR 104	Pharmaceutical Products – Naturals and Synthetics (semi optional)	**4** ***ECTS***
MOP 105	MolecularPharmacology (semi optional)	**4** ***ECTS***
MCI 106	Molecular and Cell Immunology(semi optional)	**4** ***ECTS***
TOX 108	Toxicology (Pharmacokinetics)(semi optional)	**4** ***ECTS***
REM 106	Recearch Methodology (cumpulsory)	**6** ***ECTS***
	Total (six semi optional courses + research methodology)	**30** ***ECTS***

A student will take six from the above nine semi optional courses (**total 24 ECTS points**). The executive committee will decide the semi optional courses for each student, taken into consideration the supervisor's suggestion. The final decision will be based on the undergraduate studies, the bachelor degree and the research project that will be carried out by each student during his research dissertation.

Research Methodology is a compulsory course, including the participation and the attendance in the seminars. Seminars include patent methodology, etc.

Second Semester (Compulsory courses)

LPC 200	Laboratory Course of Pharmaceutical Chemistry	**10** *ECTS*
CPR 201	Collection of Bibliography Data and Presentation of Resume Project of Research Field of Master's Thesis	**5** *ECTS*
MAT 202	Master' s Thesis (Research)	**15** *ECTS*
	Total:	**30** *ECTS*

Third Semester (Compulsory courses)

MAT 300	Master's Thesis (Research–Writing– Presentation of the Project)	**30** *ECTS*
	Total:	**30** *ECTS*

PostGraduate Program “Chemical Biology”

Departments of Chemistry, Pharmacy and Medicine

www.chem.upatras.gr/index.php/el/postgraduate

www.msc.chembiol.chem.upatras.gr

General Description

Chemical Biology is a contemporary scientific discipline, engaging the Sciences of Chemistry and Biology, which includes the application of chemical techniques and tools, often molecules which are produced by synthetic chemistry, to study and affect the biological systems. Chemical Biology finds special application in Medicinal Chemistry, a relative scientific discipline, in which the molecules are designed in such a way as to interact with biological processes and treat particular diseases. Therefore, this postgraduate program is focused on the application of techniques (analytical, spectroscopic, biochemical) and of synthetic molecules (or molecules obtained from natural sources) to the study of biological systems involved in particular diseases, and to the development, based on this study, of pharmaceutical substances for the clinical treatment of a variety of diseases.

Educational Outcomes

- Understanding, consolidation and ability for application of knowledge and techniques related to the chemistry of proteins, nucleic acids and polysaccharides, biological processes, genetics, chemical synthesis, spectroscopy and drug design.
- Developing flexibility in the combination of a variety of techniques for solving complex problems in Chemical Biology.
- Adaptability in the constantly evolving field of Chemical Biology with emphasis in the synthesis of useful molecules for facing complex problems and ability for an essential contribution to the further development of Medicinal Chemistry.
- Developing general skills, such as retrieval of useful information from database in the internet and from the primary literature (research journals, patents etc), ability to work in a research team, and both oral and written ability to communicate research results.

Professional prospects of the ‘Chemical Biology’ graduates

The knowledge and the skills which will be acquired by the graduates of this MSc program through studying and conducting research in the context of their postgraduate research diploma work, will allow them to face and readily solve interdisciplinary problems and work together harmonically with scientists from various specializations. Through this program, an improvement in the international competitiveness of the Greek scientific human resources in the field of Chemical Biology is anticipated. The effective interaction of experienced scientists/researchers, disciplines and laboratory techniques which is secured through this program, leads to the integrated training of new scientists who can be readily: (a) absorbed in vital development branches of National Economy, such the Chemical and Pharmaceutical Industry, the Veterinary and Agricultural Production (production of new generation products for veterinary and agrochemical purposes) and other branches in which Chemical Biology is applicable, (b) become experienced staff in private and state Health Service providers (such as Hospitals, Clinics, Bioanalytical Laboratories), and (c) evolved in highly competitive members of the Higher Education, through further studying for a PhD Diploma in a relevant filed, who can readily work in the interface of the various Life Sciences.

Study Program

First Semester

SOC 100	Synthetic Organic Chemistry	***5 ECTS***
SPO101	Spectroscopy of Organic Compounds	***5ECTS***
OCB 102	Organic Chemistry of Biological Processes	***5 ECTS***
PNP 103	Pharmacology - Natural Products	***5ECTS***
MBI 104	Molecular Biology	***5ECTS***
CBI 105	Cellular Biology	***5ECTS***
MCH 106	Medicinal Chemistry	***5ECTS***
	Selection of three (3) out of the above seven (7) optional courses Subtotalnumber of credits	**15 *ECTS***
ASO110	Advanced Synthetic Organic Chemistry	***5ECTS***
SFP 111	Structure and Function of Biomacromolecules – Pharmacology	**10 *ECTS***
	Total number of credits	**30 *ECTS***

Second Semester

REM 220	Research Methodology	***5 ECTS***
DDP 212	Discovery, Design and Development of Drugs – Pharmacokinetics	***10ECTS***
MAB 213	Methods of Analysis of Biologically Active Molecules	***10 ECTS***
CHB 221	Chemical Biology	***5ECTS***
	Total number of credits	**30 *ECTS***

Third Semester

PDW 330	Postgraduate Diploma Research Work - Experimental work - Writing and presentation/defense in public of the MSc Thesis	**30 *ECTS***
	Total number of credits	**30 *ECTS***

VII. RESEARCH ACTIVITIES OF THE FACULTY MEMBERS

Research in the Department of Chemistry is at the forefront of modern science, both in the core chemical discipline (Inorganic, Organic, Physical and Analytical chemistry) and as a key element of life, environmental and materials sciences (biochemistry and biochemical analysis, synthetic organic and medicinal chemistry, bioinorganic chemistry, catalysis and interfacial chemistry, food chemistry and biotechnology, polymer science, structural and environmental chemistry).

The faculty members are active in all aspects of the chemical sciences and in constant collaboration with Universities, Research Institutes and Industry in Europe, Asia and USA. Senior academics of the Department are internationally recognised scientists in their fields and through the postgraduate programs they are joined by young promising fellows who will be the leaders of tomorrow.

State-of-the-art facilities for synthesis, analysis, cell molecular biology and drug preclinical evaluation, biotechnology, interfacial and environmental chemistry within the Department, as well as the NMR and DNA-sequence facilities of the "Laboratory of Instrumental Analysis" enable the high-quality research of the Faculty members. Facilities for technical, computing and analytical support are excellent. Access to transmittance and scanning electron microscopes equipped with EDS & WDS instruments are also provided by a link to the "Laboratory of Electron Microscopy".

The Chemistry buildings house two well-equipped Multimedia Laboratories used for Seminars and Workshops, a fully equipped Seminars Room with audio and video facilities and a library with a collection of approximately 3,200 book titles.

As a department, we are strongly committed to innovation and improvement in our undergraduate and graduate programs.

Organic Chemistry

Synthetic Organic Chemistry

Faculty Members: Prof. D. Papaioannou, Assoc. Prof. C. Athanassopoulos, Assist. Prof. G. Rassias.

Medicinal Chemistry

Faculty Members: Assoc. Prof. Th. Tselios, Assoc. Prof. G. Tsivgoulis, Assist. Prof. G. Rassias.

Peptide Chemistry

Faculty Members: Prof. D. Gatos.

Biomolecules: isolation, characterization, synthesis and development of analytical methods

Faculty Members: Prof. Th. Tsegenidis.

Supramolecular Chemistry

Faculty Members: Assist. Prof. G. Tsivgoulis.

Biochemistry, Biochemical Analysis and Matrix Pathobiology

Faculty Members: Prof. N. Karamanos, Prof. D. Vynios, Assoc. Prof. A. Aletras, Assoc. Prof. A. Theocharis, Assist. Prof. A. Vlamis, Assist. Prof. S. Skandalis.

Inorganic-Bioinorganic-Organometallic Chemistry

Faculty Members: Prof. Sp. Perlepes, Assist. Prof. V. Tangoulis.

Physical Chemistry

Physical Chemistry of Interfaces

Faculty Members: Assoc. Prof. A. Koliadima.

Physical, Aquatic & Colloidal Chemistry

Faculty Members: Prof. E. Dalas.

Quantum Chemistry

Faculty Members: Prof. G. Maroulis.

Radiochemistry

Faculty Members: Assoc. Prof. H. Papaefthymiou, Assoc. Prof. M. Soupioni, Assist. Prof. B. Symeopoulos.

Catalysis and Interfacial Chemistry for Environmental Applications – Environmental Chemistry

Faculty Members: Prof. Ch. Kordulis, Assist. Prof. Ch. Matralis, Assist. Prof. Ch. Papadopoulou, Assist. Prof. H. Karapanagioti.

Food Chemistry and (Bio)Technology

Faculty Members: Prof. M. Kanellaki, Assoc. Prof. M. Soupioni. Assist. Prof. A. Bekatorou

Polymer Science and Technology

Polymer Chemistry and Technology

Faculty Members:

Advanced Polymers and Hybrid Nanomaterials

Faculty Members: Prof. J. Kallitsis, Assoc. Prof. Ch. Deimede.

Stimuli-Responsive Polymers

Faculty Members: Assoc. Prof. G. Bokias.

Analytical and Structural Chemistry

Analytical Chemistry

Faculty Members: Prof. Th. Christopoulos, Lect. D. Kalogianni.

X-ray Crystallography

Faculty Members: Prof. V. Nastopoulos.

Useful link: www.chem.upatras.gr/ResearhGroups/