ChemEngUP

UNIVERSITY OF PATRAS

Department Of Chemical Engineering

2018-2019

# DEPARTMENTAL CURRICULUM

Revision Nr. 1

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ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΑΤΡΩΝ
UNIVERSITY OF PATRAS

ChemEngUP

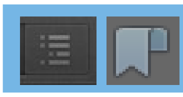
SCHOOL OF ENGINEERING

DEPARTMENT OF CHEMICAL ENGINEERING

# DEPARTMENTAL CURRICULUM of Undergraduate Studies

# 2018 - 2019

CARE OF PRESENTATION: S. Bebelis, Professor



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- IF YOU ARE USING A BROWSER: OPEN THE document outline of the adobe reader PLUGIN
- IF YOU ARE USING adobe reader: OPEN THE BOOKMARKS

# Table of Contents

# 1. THE DEPARTMENT OF CHEMICAL ENGINEERING

## 1.1 Introduction

The Department of Chemical Engineering of the School of Engineering of the University of Patras (ChemEngUP) was established in 1977. It is housed in two modern buildings located at the University of Patras Campus, with magnificent views of the mountains of Peloponnese and the Gulf of Patras.

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

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

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

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

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

## 1.2 Mission

The mission of ChemEngUP is twofold:

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

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

Specific targets of the Department are as follows:

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

## 1.3 Professional Ethics and Integrity Policy

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

Specifically, ChemEngUP:

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

Cited Documents:

1. Professional Code of Greek Engineers (in Greek)

2. [Code of Conduct of European Chartered Engineers]
3. [FEANI Position Paper on Code of Conduct: Ethics and Conduct of Professional Engineers]
4. [AIChE Code of Ethics]

## 1.4 Health and Safety Policy

A. General principles

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

The Department recognizes that:

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

B. Scope

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

C. Responsibilities

- The Chairman of ChemEngUP has overall supervision of Health and Safety within the Department.
- The Chairman of ChemEngUP assigns the day-to-day responsibility of all practical aspects of Health and Safety regarding planning, training and supervision to the HSC.
- The Chairman of HSC assists and advises the Chairman and all other members of the Department on Health and Safety issues. The Chairman of HSC also conducts the investigation of any reported incident , carries out regular safety audits and supervises the compulsory training of students and staff on Health and Safety issues.

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

D. Training

ChemEngUP is committed to ensuring that:

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

Also, ChemEngUP

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

E. Planning and Supervision

- ChemEngUP is committed to working for the continuous improvement of Health and Safety standards in its facilities through the implementation of an integrated management system.
- Considers that Health and Safety are essential elements in the design of curricula and new research programmes.
- Recognizes the need to monitor and regularly discuss in the Departmental Staff Meeting the current performance level of the Health and Safety system and react appropriately.
- Recognizes the need to regularly review policies and procedures to ensure Health and Safety of staff, students and visitors within its premises.

F. Cited Documents:

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

## 1.5 ChemEngUP Personnel

### A. Professors and Lecturers

| | Name | Rank | Studies | Area |
|---|---|---|---|---|
| 1 | G. N. Angelopoulos | Professor | *Mechanical Engineer*<br>PhD University of Patras (1990) | Materials Technology |
| 2 | E. Amanatides | Assoc. Professor | *Chemist*<br>PhD University of Patras (2001) | Nanostructured Materials |
| 3 | S. Bebelis | Professor | *Chemical Engineer*<br>PhD University of Patras (1989) | Catalysis, Electrochemistry |
| 4 | S. Boghosian | Professor | *Chemical Engineer*<br>PhD University of Patras (1990) | Applied Molecular Spectroscopy |
| 5 | Y. Dimakopoulos | Ass. Professor | *Chemical Engineer*<br>PhD University of Patras (2003) | Transport Phenomena |
| 6 | M. Dimarogona | Ass. Professor | *Chemical Engineer*<br>MRes Universite Paris Descartes (2007)<br>PhD National Technical University of Athens (2012) | Biochemical Engineering |
| 7 | C. Galiotis | Professor | *Chemist*<br>PhD Q. Mary University of London (1982) | Composites, Nanomaterials, Nanotechnology |
| 8 | A. Katsaounis | Assoc. Professor | *Chemical Engineer*<br>PhD University of Patras (2004) | Electrochemical Processes |
| 9 | S. Kennou | Professor | *Physicist*<br>PhD University of Ioannina (1984) | Surface Physics |
| 10 | D. Kondarides | Professor | *Chemist*<br>PhD University of Patras (1994) | Heterogeneous Catalysis and Photocatalysis |
| 11 | M. Kornaros | Professor | *Chemical Engineer*<br>PhD University of Patras (1995) | Waste Management |
| 12 | I. Kookos | Professor | *Chemical Engineer*<br>PhD Imperial College London (2001) | Process Synthesis |
| 13 | D. Kouzoudis | Assoc. Professor | *Physicist*<br>PhD Iowa state University (1998) | Applied Physics |
| 14 | S. Ladas | Professor | *Chemical Engineer*<br>PhD Stanford (1980) | Surface Science |
| 15 | D. Mantzavinos | Professor | *Chemical Engineer*<br>PhD Imperial College london (1996) | Wastewater Treatment |
| 16 | D. Mataras | Professor | *Chemical Engineer*<br>PhD University of Patras (1990) | Plasma Technology |
| 17 | V. Mavrantzas | Professor | *Chemical Engineer*<br>PhD University of Delaware (1994) | Molecular Modelling |
| 18 | S. Pandis | Professor | *Chemical Engineer*<br>PhD CalTech (1991) | Air Polution |
| 19 | Ch. Paraskeva | Professor | *Chemical Engineer*<br>PhD University of Patras (1992) | Separation Processes |
| 20 | S. Pavlou | Professor | *Chemical Engineer*<br>PhD University of Minnesota (1983) | Biochemical Processes |
| 21 | D. Spartinos | Lecturer | *Chemical Engineer*<br>PhD University of Patras (1993) | Chemical Processes |
| 22 | V. Stivanakis | Lecturer | *Chemical Engineer*<br>PhD University of Patras (2003) | Inorganic Materials |
| 23 | I. Tsamopoulos | Professor | *Chemical Engineer*<br>PhD MIT (1985) | Transport Phenomena |
| 24 | C. Tsitsilianis | Professor | *Chemist*<br>PhD University of Patras (1987) | Polymers |
| 25 | P. Vafeas | Ass. Professor | *Chemical Engineer*<br>PhD University of Patras (2003) | Applied Mathematics |
| 26 | D. Vayenas | Professor | *Chemical Engineer*<br>PhD University of Patras (1995) | Water & Wastewater Treatment |

## B. Professors Emeriti

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

## C. Other Teaching, Technical and Support Staff

| | Name | Studies | Graduate Studies |
|---|---|---|---|
| 1 | C. Alexandridou | *Chemical Engineer, University of Patras* | MSc Hellenic Open University |
| 2 | E. Alexopoulou | *Mining & Metallurgical Engineer, NTUA* | PhD University of Patras |
| 3 | E. Antonopoulou | *Liceum* | |
| 4 | M. Theodorakopoulou | *Economist, University of Piraeus* | |
| 5 | U. Kouli | *Chemical Engineer, University of Patras* | |
| 6 | I. Katsigianni | *Liceum* | |
| 7 | E. Mavreli | *Liceum* | |
| 8 | S. Brosda | *Chemist, University of Greifswald* | PhD University of Greifswald |
| 9 | Ch. Pilisi | *Liceum* | |
| 10 | K. Santas | *Electrical Engineer TE, TEI of Western Greece* | |
| 11 | I. Sionakidis | *Chemist* | MSc Lehigh University |
| 12 | S. Sfikas | *Electrical Engineer, University of Patras* | PhD University of Patras |
| 13 | E. Stamatiou | *Liceum* | |
| 14 | D. Sotiropoulou | *Chemical Engineer, University of Patras* | PhD University of Patras |
| 15 | M. Sypsa | *Business Administration, Hellenic Open University* | |
| 16 | M. Tsami | *Chemist* | MSc Université Paul Sabatier, Toulouse |
| 17 | S. Fanariotis | *Mathematician University of Ioannina* | |

## C. Teaching Staff with Appointment

| | Name | Studies | Graduate Studies |
|---|---|---|---|
| 1 | N. Balis | *Physicist, University of Patras* | PhD University of Patras (2013) |
| 2 | E. Farsari | *Chemical Engineer, University of Patras* | PhD University of Patras (2015) |

# 2. DIPLOMA IN CHEMICAL ENGINEERING

## 2.1 General Information

Diploma studies at ChemEngUP last five (5) academic years, divided in ten (10) semesters. Each semester includes thirteen (13) full weeks of lectures. The academic year starts on September 1st and ends on August 31st. Normally, classes of the fall semester begin on October 1st and classes of the spring semester on February 16th; however, the exact academic calendar is defined by the University Senate, and announced three months before the start of each academic year at the University of Patras website.

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

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

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

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

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

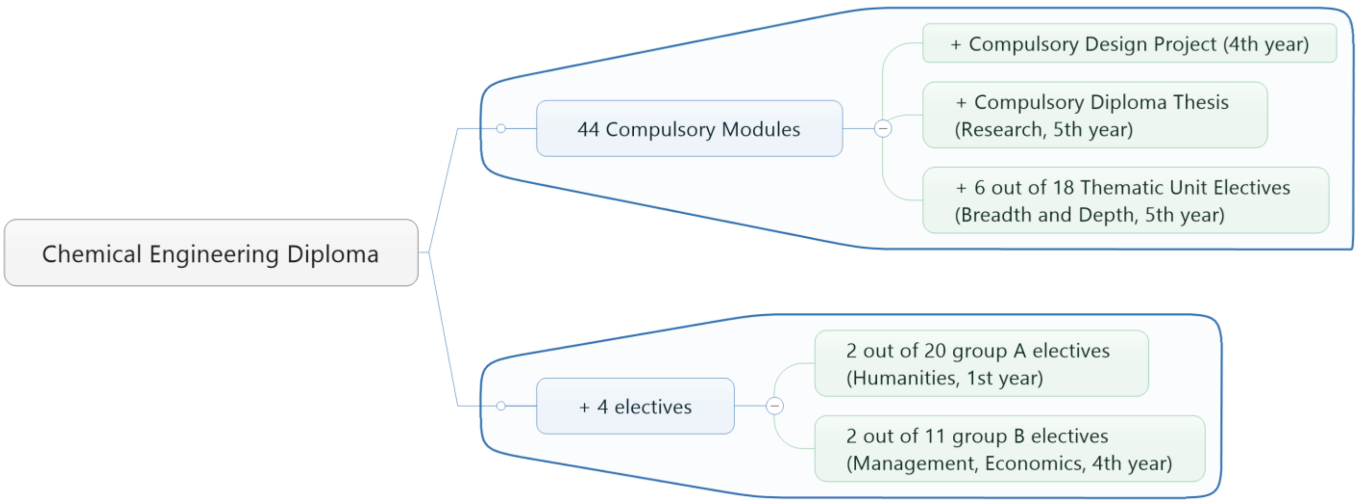
## 2.2 Teaching Assignment

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

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

## 2.3 Program Structure

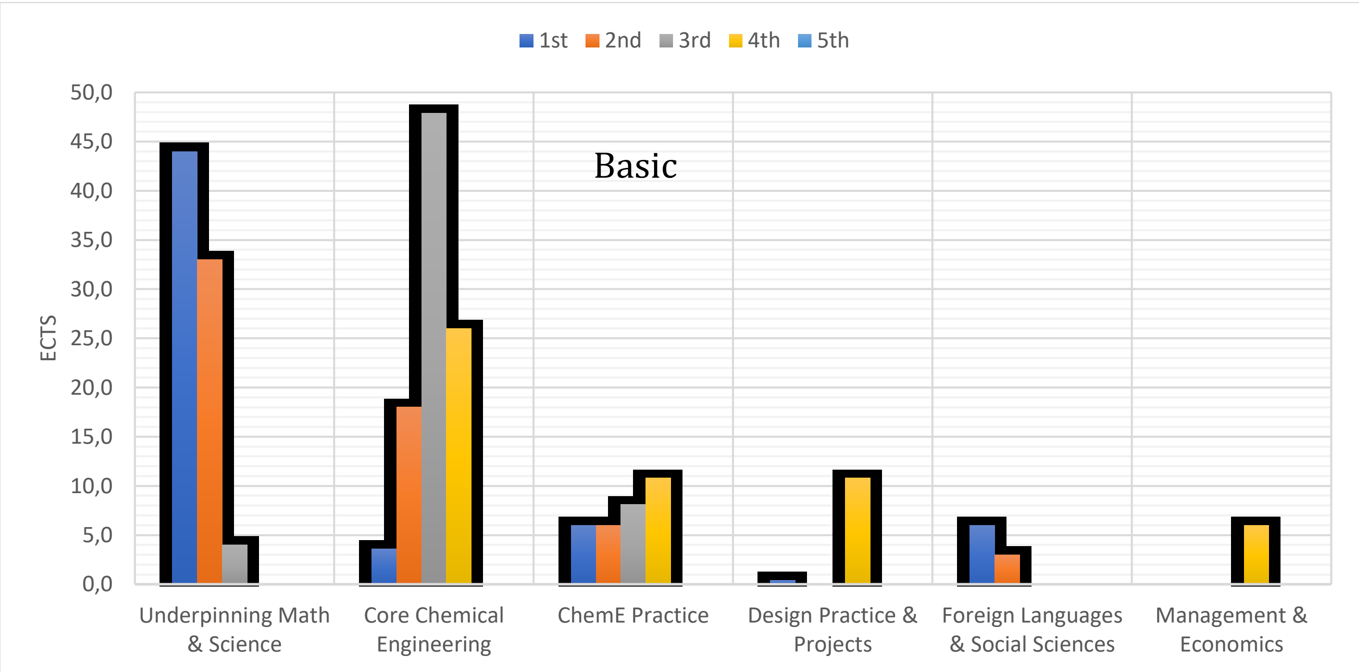
The "*Chemical Engineering Diploma*" programme is composed by 45 compulsory modules, compulsory Design Project and Diploma Thesis (equivalent to 12 modules). This is complemented by 10 electives in three groups. Two electives from group A (humanities), two from group B (management and economics) and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

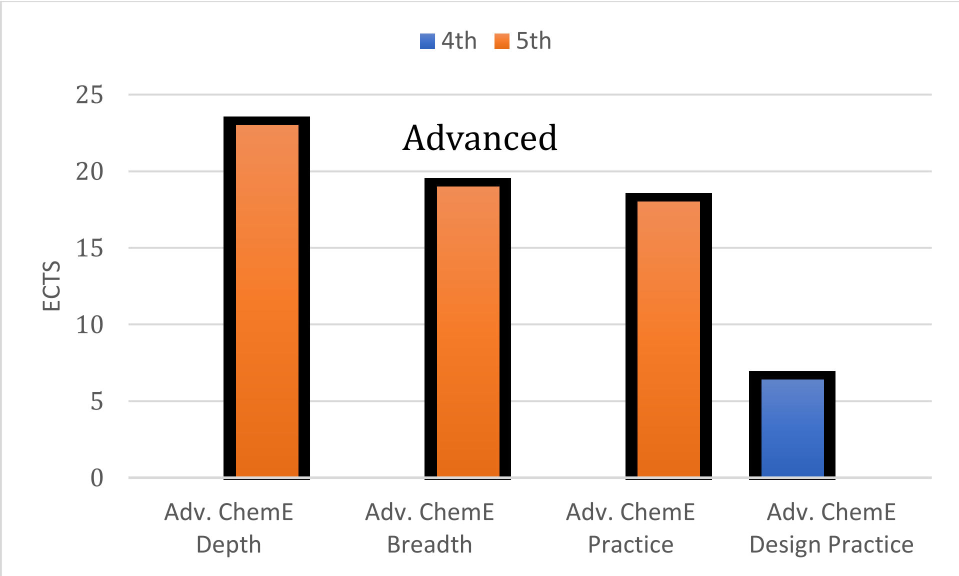



1st to 8th semesters are dedicated to underpinning math and science, core chemical engineering, practice and Design while semesters 8 to 10 focus to advanced chemical engineering subjects and the Diploma Thesis as shown in the following table and graphs.

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

| subject categories | year of study 1st | 2nd | 3rd | 4th | 5th |
|---|---|---|---|---|---|
| **Basic** | | | | | |
| Underpinning Math & Science | 44.0 | 33.0 | 4.0 | | |
| Core Chemical Engineering | 3.6 | 18.0 | 47.9 | 26.0 | |
| ChemE Practice | 6.0 | 6.0 | 8.1 | 10.8 | |
| Design Practice & Projects | 0.4 | | | 10.8 | |
| Foreign Languages & Social Sciences | 6.0 | 3.0 | | | |
| Management & Economics | | | | 6.0 | |
| **Advanced** | | | | | |
| Adv. ChemE Depth | | | | | 23.0 |
| Adv. ChemE Breadth | | | | | 19.0 |
| Adv. ChemE Practice | | | | | 18.0 |
| Adv. ChemE Design Practice | | | | 6.4 | |
| | **60.0** | **60.0** | **60.0** | **60.0** | **60.0** |






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

## 2.4 1st Year – 1st Semester

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

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

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

| | TU | ECTS |
|---|---|---|
| SUM | 25 | 30 |

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

## 2.5 1st Year – 2nd Semester

| MN | MODULES | HOURS/WEEK T | R | L | TU | ECTS | INSTRUCTOR |
|---|---|---|---|---|---|---|---|
| | COMPULSORY MODULES | | | | | | |
| CHM_201 | Multivariable Calculus and Vector Analysis | 4 | 2 | _ | 5 | 7 | P. Vafeas |
| CHM_212 | Organic Chemistry | 3 | 2 | _ | 4 | 7 | E. Amanatides |
| CHM_215 | Laboratory of Analytical Chemistry | _ | _ | 4 | 2 | 3 | E. Amanatides |
| CHM_230 | Physics II | 3 | 1 | _ | 4 | 7 | N. Balis |
| CHM_232 | Physics Laboratory | _ | _ | 4 | 2 | 3 | S. Kennou - D. Kouzoudis |

T:Teaching, R: Recitation, L: Laboratory

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

| | TU | ECTS |
|---|---|---|
| SUM | 20 | 30 |

## 2.6 2nd Year – 3rd Semester

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

## 2.7 2nd Year – 4th Semester

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

T:Teaching, R: Recitation, L: Laboratory

## 2.8 3rd Year – 5th Semester

| MN | MODULES | HOURS/WEEK T | R | L | TU | ECTS | INSTRUCTOR |
|---|---|---|---|---|---|---|---|
| | COMPULSORY MODULES | | | | | | |
| CHM_550 | Fluid Mechanics | 3 | 2 | _ | 4 | 6 | I. Tsamopoulos |
| CHM_570 | Polymer Science & Technology | 3 | 1 | _ | 4 | 5 | C. Tsitsilianis |
| CHM_540 | Technical Thermodynamics and Balances | 3 | 2 | _ | 4 | 6 | S. Ladas - D. Spartinos |
| CHM_381 | Materials Science | 3 | 2 | _ | 4 | 6 | S. Kennou - D.Kouzoudis |
| CHM_680 | Microbiology | 3 | _ | _ | 3 | 4 | D. Vayenas _M. Dimarogona |
| CHM_481 | Materials Laboratory | _ | _ | 4 | 2 | 3 | V. Stivanakis |
| | SUM | | | | 21 | 30 | |

## 2.9 3rd Year – 6th Semester

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

T:Teaching, R: Recitation, L: Laboratory

## 2.10 4th Year - 7th Semester

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

T:Teaching, R: Recitation, L: Laboratory

| | ELECTIVES: GROUP B | | | | | | |
|---|---|---|---|---|---|---|---|
| CHM_795 | Production and Project Management | 3 | _ | _ | 3 | 3 | MEAD |
| CHM_796 | Introd. to Business Administration | 3 | _ | _ | 3 | 3 | MEAD |
| CHM_798 | General Ecology | 3 | _ | _ | 3 | 3 | DBIOL |
| CHM_799 | Operational Research | 3 | _ | _ | 3 | 3 | BMA |
| CHM_780 | Introduction to Economics for Engineers and Scientists | 3 | _ | _ | 3 | 3 | DECON |
| CHM_781 | Introduction to Business Administration for Engineers and Scientists | 3 | _ | _ | 3 | 3 | BMA |

| | TU | ECTS |
|---|---|---|
| SUM | 22 | 30 |

NOTES:

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

## 2.11 4th Year – 8th Semester

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

T:Teaching, R: Recitation, L: Laboratory

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

| SUM | TU | ECTS |
|---|---|---|
| SUM | 22 | 30 |

## 2.12 5th Year – 9th Semester

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

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

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

Six (6) elective modules that are related to the subject of the Diploma Thesis must be elected from the THEMATIC UNIT ELECTIVES, specifically three (3) in the 9th and three (3) in the10th semester. The selection process is as follows: two (2) modules are selected by the supervisor of the Diploma Thesis, another two (2) modules are selected by the student from the electives of the thematic unit associated with the Diploma Thesis, and the remaining two (2) can be selected from any of the remaining electives.
The content and layout of the Diploma Thesis need to conform to specific template and guidelines, which are clearly described in a manual uploaded in the ChemEngUP website. The Diploma Thesis is examined by a committee of three (3) examiners, two permanent members and the supervisor, which, for a given academic year, is assigned to assess all Diploma Theses associated with a thematic unit. The examiners consult a marking scheme and procedure for marking the thesis and the related oral examination. Plagiarism is checked using pertinent software tools available both to students and faculty.

## 2.13 5th Year – 10th Semester

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

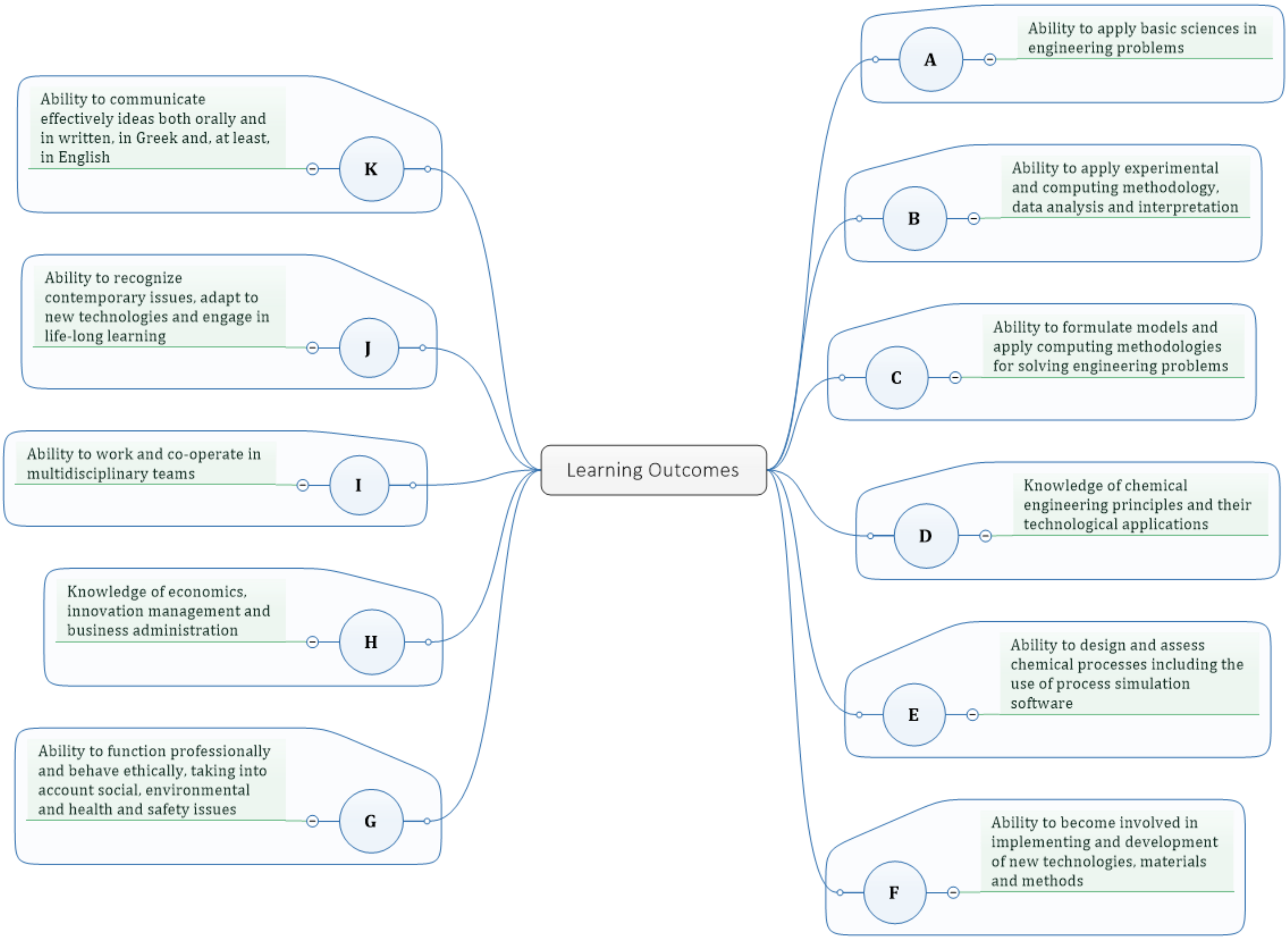
T:Teaching, R: Recitation, L: Laboratory

## 2.14 Thematic Unit Electives

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

# 3. MODULE DESCRIPTIONS

## 3.1 Categories of Learning Outcomes (CAT)




## 3.2 1st Year – 1st Semester

Single Variable Calculus and Linear Algebra

| **Module code** | **CHM_102** | | | |
|---|---|---|---|---|
| **Module title** | ***Single Variable Calculus and Linear Algebra*** | | | |
| **Status** | Live | **Type** | Compulsory | |
| **Category A** | Underpinning Mathematics, Science and Associated engineering | | **%** | 100% |
| **Category B** | | | **%** | % |
| **Year of study** | 1 | **Semester** | Fall | |
| **ECTS credits** | 6 | **Teaching Units** | 5 | |
| **Name of lecturer** | Panayiotis Vafeas | | | |
| **Learning outcomes** | **CAT** | **Description** | | |

| **Module code** | **CHM_102** | |
|---|---|---|
| | A | Knowledge of the new notions in the form of definitions and theorems that concern the basic contents of the module "Single Variable Calculus and Linear Algebra", in order to be able to apply them. |
| | F | A good understanding of the knowledge of the basic applied mathematics for engineers, within the wide area of the differential and integral calculus of one variable, of the series of numbers and functions, as well as of the linear algebra, which is adequate to his/her science. |
| | I | Ability tocombine and make worthy of the knowledge that he/she acquired to other fields of the theoretical and applied mathematics, in which certain notions and principles of the present module are necessary and usefulto multidisciplinary subjects. |
| | I | Ability to demonstrate knowledge and understanding of essential concepts, principles and applications that are related to the differential and integral calculus of one variable, to the series of numbers and functions, as well as to the linear algebra |
| | A | Ability to apply such knowledge to the solution of problems in other fields of the wide conception of theoretical and applied mathematics, related to the science of Chemical Engineering, or to the solution of multidisciplinary problems. |
| | F | Study skills needed for continuing profession development. |
| **Competences Prerequisites** | There are no prerequisite modules. It is, however, recommended that students should have a basic knowledge of the differential and integral calculus of one variable, as well as of the principal theory of vectors from school. | |
| **Module content** | Introduction to the calculus of one variable. Functions of one variable, the conception of representation, limit and continuity. Derivative of first or higher order of functions, derivation rules and total differential. Inverse and composite functions, parametric equations, complex forms and L' Hospital's rule. Analysis, monotony and extremities of functions, asymptotes. Fermat's theorem and theorems of mean value. Sequences, number series and convergence criterions. Series of functions, uniform convergence criterions and power series. Taylor's formula and local approximation of function, binomial expansion. Taylor's and Maclaurin's series, binomial series and convergence. Fourier's series and total approximation of function. Applications of derivatives with the use of method of extremities for functions of physical interest, finding the curvature of a plane curve and introduction of ordinary differential equations. Indefinite integral of functions and several analytic techniques of integration. Riemann's integral, definite integral and main numerical methods of integration. Generalized integrals and their relation with the series. Applications of integrals to the calculation of plane areas, curve's length, surface areas and domain volumes by rotation. Introduction of vectors, inner, exterior, mixed and double–exterior product, geometrical meaning. Matrix theory and square matrices, determinant and inverse matrix. Vector spaces, linear dependence and independence, vector subspaces, basis and dimension, extension and change of basis in a particular vector space. Homogeneous and non homogeneous systems of linear equations, solution with Gauss' method. Spectral analysis of matrix, eigenvalues and eigenvectors, physical meaning and Cayley–Hamilton's theorem. Algebraic and geometric multiplicity of eigenvalues, diagonalization of square matrix. Degenerate eigenvalues, degeneration degree and generalized eigenvectors, Jordan's matrix. Generalization of inner product, the meaning of norm, distance and orthonormalization with Gram–Schmidt's method. | |
| **Recommended[8] literature** | 1. Β.Β. Μάρκελλος, "Εφαρμοσμένα Μαθηματικά", Εκδόσεις Γκότσης Κων/νος & ΣΙΑ Ε.Ε., Πάτρα, 2013. | |
| | 2. Κ.Ε. Παπαδάκης, "Εφαρμοσμένα Μαθηματικά", Εκδόσεις Α. Τζιόλας & Υιοί Α.Ε., Θεσσαλονίκη, 2014. | |

| **Teaching and learning methods** | **LECTURES** | **RECITATION** | **LAB/PRACTICE** | **PROJECT / HOMEWORK** |
|---|---|---|---|---|

| Module code | CHM_102 | | | |
|---|---|---|---|---|
| | 4 h/w | 2 h/w | 2 h/w | 0/semester |
| Assessment type | Written Examination | | | |
| Assessment and grading methods | Final written and/or oral exam | | | |
| Instruction Language | Greek | | | |
| Erasmus availability | NO | | | |
| Module URL | http://www.chemeng.upatras.gr/en/content/modules/en/single-variable-calculus-and-linear-algeb | | | |
| Last Amendment | December 2016 | | | |

## Analytical Chemistry

| Module code | CHM_115 | | | |
|---|---|---|---|---|
| Module title | ***Analytical Chemistry*** | | | |
| Status | Live | **Type** | Compulsory | |
| Category A | Underpinning Mathematics, Science and Associated engineering | | **%** | 100% |
| Category B | | | **%** | % |
| Year of study | 1 | **Semester** | Fall | |
| ECTS credits | 4 | **Teaching Units** | 3 | |
| Name of lecturer | Eleftherios Amanatides | | | |
| Learning outcomes | **CAT** | **Description** | | |
| | A | Comprehension of the principles of chemical equilibrium, with application in solutions of electrolytes | | |
| | A | Extended and in depth study of the ionic equilibriums | | |
| | A | Calculation of concentrations from equilibrium constants | | |
| | A | Comprehension of basic concepts of analytical chemistry, which find application in qualitative, as well in quantitative analysis. | | |
| Competences Prerequisites | There are no prerquisite modules.<br>Students should have a basic knowledge of chemistry | | | |
| Module content | Introductory concepts. Solutions. The water as a solvent.<br>Chemical reactions and chemical equilibrium.<br>Concentration of solutions.<br>Reaction velocity and chemical equilibrium.<br>Equilibria of weak acids and weak bases.<br>Ionization of water, pH, protolytic indicators, buffer solutions, hydrolysis.<br>Equilibria of insoluble substances and their ions, solubility product, formation of precipitates.<br>Equilibrium of complex ions.<br>Amphoteric substances.<br>Equilibria of redox systems, galvanic cells. | | | |
| Recommended[8] literature | 1. “Χημική Ισορροπία και Ανόργανη Ποιοτική Ημιμικροανάλυση”, Μέρος πρώτο, Θ. Π. Χατζηιωάννου, Αθήνα, 1996. | | | |
| | 2. “Αναλυτική Χημεία, Θέματα και Προβλήματα”, Στυλιανός Λιοδάκης, Παπασωτηρίου Εκδόσεις, 2001. | | | |

| Module code | CHM_115 | | | |
|---|---|---|---|---|
| Teaching and learning methods | LECTURES | RECITATION | LAB/PRACTICE | PROJECT / HOMEWORK |
| | 2 h/w | 1 h/w | 0 h/w | 0/semester |
| Assessment type[9] | Written Examination | | | |
| Assessment and grading methods | Final written and/or oral exam | | | |
| Instruction Language | Greek | | | |
| Erasmus availability | NO | | | |
| Module URL | https://eclass.upatras.gr/modules/CMNG2139 | | | |
| Last Amendment | June 2016 | | | |

## Introduction to Chemical Engineering

| Module code | CHM_140 | | | |
|---|---|---|---|---|
| Module title | *Introduction to Chemical Engineering* | | | |
| Status | Live | Type | Compulsory | |
| Category A | Core Chemical Engineering | | % | 90% |
| Category B | Chemical Engineering Design Practice and Design Projects | | % | 10% |
| Year of study | 1 | Semester | Fall | |
| ECTS credits | 4 | Teaching Units | 4 | |
| Name of lecturer | Dimitris Vayenas, Alexandros Katsaounis | | | |
| Learning outcomes | CAT | Description | | |
| | A | Understand a flowsheet of a simple Chemical Industry. Develop the physical and mathematical model of a process | | |
| | A | Use fundamental equations and write mass and energy balances in simple processes. Understand the concept of linearization. | | |
| | B | Use differential and integral methods for the treatment of reaction rate data. | | |
| | B | Use dimensional analysis in order to extract equations. | | |
| | D | Write mass and energy balances of chemical compounds in simple physical processes and simple chemical reactors. | | |
| | C | Design an ideal isothermal reactor for a specific process. | | |
| Competences Prerequisites | No | | | |
| Module content | Definition of Chemical Engineering science and activities of Chemical Engineers in Greece. Overview of the flowsheet of a simple Chemical Industry in relation to the modules in the Chemical Engineering curriculum. Physical and mathematical model of a process. Types of chemical and electrochemical reactors. Mass balances in simple chemical reactors and simple unit operations. Use of differential and integral methods for the treatment of reaction rate data. How to design an ideal isothermal reactor for a specific process. Dimensional analysis. The concept of scale-up. The concept of linearization. Residence time distribution (RTD) in simple single- and multi-chemical reactors. | | | |
| Recommended literature | 1. ′′Introduction to Chemical Engineering′′ Notes of Professor Costas Vayenas | | | |
| | 2. ′′Perry's standard tables and formulas for chemical engineers′′, Speight James G., Tziola's Editions (ISBN: 978-960-418-146-9) | | | |

| Module code | CHM_140 | | | |
|---|---|---|---|---|
| | 3. ′′Basic principles and calculations in chemical engineering′′, Himmelblau D., Riggs J., Tziola's Editions (ISBN: 960-418-105-X) | | | |
| Teaching and learning methods | LECTURES | RECITATION | LAB/PRACTICE | PROJECT / HOMEWORK |
| | 3 h/w | 2 h/w | 0 h/w | 3/semester |
| Assessment type[9] | Combined | | | |
| Assessment and grading methods | Problem solving by the students during the semester. One elementary project focusing on the design of an ideal isothermal reactor for a specific process (1 unit bonus on the final mark, if it is > 5).<br>Written examination in the middle of the semester (50% of the final mark)<br>Final written exam (50 % of the final mark) | | | |
| Instruction Language | Greek | | | |
| Erasmus availability | NO | | | |
| Module URL | https://eclass.upatras.gr/modules/CMNG2141/ | | | |
| Last Amendment | January 2017 | | | |

Physics I

| Module code | CHM_130 | | | |
|---|---|---|---|---|
| Module title | ***Physics I*** | | | |
| Status | Live | Type | Compulsory | |
| Category A | Underpinning Mathematics, Science and Associated engineering | | % | 100% |
| Category B | | | % | % |
| Year of study | 1 | Semester | Fall | |
| ECTS credits | 5 | Teaching Units | 4 | |
| Name of lecturer | Dimitris Kouzoudis | | | |
| Learning outcomes | CAT | Description | | |
| | A | Ability to apply basic sciences in engineering problems | | |
| | B | Ability to apply experimental and computing methodology, data analysis and interpretation | | |
| | C | Ability to formulate models and apply computing methodologies for solving engineering problems | | |
| Competences Prerequisites | Basic High School Algebra, Geometry and Mathematics | | | |

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

## General and Inorganic Chemistry

| **Module code** | **CHM_110** | | | |
|---|---|---|---|---|
| **Module title** | ***GENERAL AND INORGANIC CHEMISTRY*** | | | |
| **Status** | Live | **Type** | Compulsory | |
| **Category A** | Underpinning Mathematics, Science and Associated engineering | | **%** | 100% |
| **Category B** | | | **%** | % |
| **Year of study** | 1 | **Semester** | Fall | |

<table>
<tr><td>Module code</td><td colspan="4">CHM_110</td></tr>
<tr><td>ECTS credits</td><td colspan="2">5</td><td>Teaching Units</td><td>4</td></tr>
<tr><td>Name of lecturer</td><td colspan="4">Dimitris Kondarides</td></tr>
<tr><td rowspan="7">Learning outcomes</td><td>CAT</td><td colspan="3">Description</td></tr>
<tr><td>A</td><td colspan="3">Understand fundamentals of atomic structure and of the steps leading to the development of modern atomic theories</td></tr>
<tr><td>A</td><td colspan="3">Understanding bonding in molecules and of the way that electro distribution in atoms in their compounds affects molecular shape and other macroscopic properties of materials</td></tr>
<tr><td>A</td><td colspan="3">Understanding and predicting macroscopic properties of materials on the basis of intermolecular forces</td></tr>
<tr><td>A</td><td colspan="3">Ability for use of the information involved in the periodic table of the elements for the prediction of physical, chemical properties of materials, their reactivity and of the electronic structure of the atoms.</td></tr>
<tr><td>A</td><td colspan="3">Understanding of the importance of interactions at the atomic and molecular level for the prediction of physical and chemical properties of materials.</td></tr>
<tr><td>I</td><td colspan="3">Relating knowledge of physical and chemical phenomena with everyday life.</td></tr>
<tr><td>Competences Prerequisites</td><td colspan="4">General Chemistry (High School level)</td></tr>
<tr><td>Module content</td><td colspan="4">Atoms, molecules and ions. Early atomic theories. From ancient Greeks to the modern atomic theories. Quantum principles. Thomson's experiment. Millikan experiment. Discreetness of atomic spectra. Planck's theory. Atomic models of J.J.Thomson, Rutherford, N.Bohr. The De Broglie theory and atomic model. Where are the electrons? Atomic orbitals and quantum numbers. The properties of atomic orbitals. The pauli and Hund's rules. The effective nuclear charge. Shielding and penetration. The aufbau principle for the electronic conformation of atoms. Exceptions from the rules. Pseudonoble gas configuration. The electronic configuration of ions. Atomic structure and the periodic table. Properties of the elements and periodic trends of their physical and chemical properties. Chemical bonding. Lewis structures. Formal charges and oxidation number. Resonance. VSEPR theory. Molecular geometry. Valence bond theory. Hybridization of atomic orbitals. Molecular orbital theory. The LCAO method. Modern aspects of chemical bond. Forces between atoms and molecules and their consequences to physical properties of materials.. Solids and Liquids. Elements of chemical thermodynamics and chemical kinetics.Chemical Equilibrium. Acids, bases and salts. The strength of acids and bases. Complexes of the elements of the d-block.</td></tr>
<tr><td rowspan="2">Recommended literature</td><td colspan="4">1. Ebbing: General Chemistry, 4th Ed. , Houghton, 1993.</td></tr>
<tr><td colspan="4">2. Εφαρμοσμένη Ανόργανη Χημεία, Σ.Λιοδάκης, Εκδ. Παρισιάνου 2003</td></tr>
<tr><td rowspan="2">Teaching and learning methods</td><td>LECTURES</td><td>RECITATION</td><td>LAB/PRACTICE</td><td>PROJECT / HOMEWORK</td></tr>
<tr><td>3 h/w</td><td>1 h/w</td><td>0 h/w</td><td>2/semester</td></tr>
<tr><td>Assessment type</td><td colspan="4">Combined</td></tr>
<tr><td>Assessment and grading methods</td><td colspan="4">Short, 15 min exams are given during the semester (8-10 exams). 15% of the average is added to the final exam mark. 2 homework assignments, 10% of the average is added to the final exam mark. Final written and/or oral examination</td></tr>
<tr><td>Instruction Language</td><td colspan="4">Greek</td></tr>
<tr><td>Erasmus availability</td><td colspan="4">YES</td></tr>
<tr><td>Module URL</td><td colspan="4">https://eclass.upatras.gr/courses/CMNG2122/</td></tr>
<tr><td>Last Amendment</td><td colspan="4">December 2016</td></tr>
</table>

## Computers Laboratory

<table>
<tr><td>Module code</td><td colspan="4">CHM_163</td></tr>
<tr><td>Module title</td><td colspan="4">Computers Laboratory</td></tr>
<tr><td>Status</td><td colspan="2">Live</td><td>Type</td><td>Compulsory</td></tr>
<tr><td>Category A</td><td colspan="2">Underpinning Mathematics, Science and Associated engineering</td><td>%</td><td>100%</td></tr>
<tr><td>Category B</td><td colspan="2"></td><td>%</td><td>%</td></tr>
<tr><td>Year of study</td><td colspan="2">1</td><td>Semester</td><td>Fall</td></tr>
<tr><td>ECTS credits</td><td colspan="2">3</td><td>Teaching Units</td><td>2</td></tr>
<tr><td>Name of lecturer</td><td colspan="4">Ergina Farsari</td></tr>
<tr><td rowspan="5">Learning outcomes</td><td>CAT</td><td colspan="3">Description</td></tr>
<tr><td>B</td><td colspan="3">Ability to use Excel for data analysis and presentation</td></tr>
<tr><td>B</td><td colspan="3">Ability to use Matlab for data analysis and presentation</td></tr>
<tr><td>C</td><td colspan="3">Ability to use Matlab as a tool for solving basic engineering problems</td></tr>
<tr><td>K</td><td colspan="3">Writing and presentation of original reports</td></tr>
<tr><td>Competences Prerequisites</td><td colspan="4">General computing skills (High School level)</td></tr>
<tr><td>Module content</td><td colspan="4"><ul><li>Introduction to engineering computation. Analytical vs algorithmic problem solving. Data retrieval, analysis and visualization.</li><li>Introduction to EXCEL, using the spreadsheet, data formatting, excel functions, logic expressions, iterative solution, lookup tables, linear regression, using the solver, data visualization in EXCEL.</li><li>Introduction to MATLAB, command line processing, script files, function files, vectors and matrices, plotting in MATLAB.</li><li>MATLAB programming, branching and loops, data output.</li><li>Elementary applications: roots of equations, matrix operations, solving systems of equations, numerical integration and optimization.</li></ul></td></tr>
<tr><td rowspan="2">Recommended literature</td><td colspan="4">1. Engineering Computations, An Introduction Using MATLAB and EXCEL. J. C. Musto, W. E. Howard and R. R. Williams. McGraw Hill 2009. ISBN 978-007-126357-3</td></tr>
<tr><td colspan="4">2. Υπολογιστική Μηχανική με Matlab και Excel, J. C. Musto, W. E. Howard and R. R. Williams, Εκδόσεις Τζιόλα. ISBN 978-960-418-504-7</td></tr>
<tr><td rowspan="2">Teaching and learning methods</td><td>LECTURES</td><td>RECITATION</td><td>LAB/PRACTICE</td><td>PROJECT / HOMEWORK</td></tr>
<tr><td>1 h/w</td><td>0 h/w</td><td>2 h/w</td><td>6/semester</td></tr>
<tr><td>Assessment type</td><td colspan="4">During the semester</td></tr>
<tr><td>Assessment and grading methods</td><td colspan="4">Average mark of six original homework reports based on individual data retrieval, analysis and presentation</td></tr>
<tr><td>Instruction Language</td><td colspan="4">Greek and English</td></tr>
<tr><td>Erasmus availability</td><td colspan="4">YES</td></tr>
<tr><td>Module URL</td><td colspan="4">https://eclass.upatras.gr/courses/CMNG2112/</td></tr>
<tr><td>Last Amendment</td><td colspan="4">December 2016</td></tr>
</table>

## History of Technology I

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

## Introduction to Philosophy

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

## Human Rights

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

## French I

| | | | | |
|---|---|---|---|---|
| **Module code** | **CHM_192** | | | |
| **Module title** | ***French I*** | | | |
| **Status** | Live | **Type** | Elective | |
| **Category A** | Foreign Language & Social Sciences | | **%** | 100% |
| **Year of study** | 1 | **Semester** | Fall | |
| **ECTS credits** | 3 | **Teaching Units** | 3 | |
| **Name of lecturer(s)** | Foreign Languages Teaching Unit | | | |

## German I

| | | | |
|---|---|---|---|
| **Module code** | **CHM_193** | | |
| **Module title** | ***German I*** | | |
| **Status** | Live | **Type** | Elective |

| | | | | |
|---|---|---|---|---|
| **Module code** | **CHM_193** | | | |
| **Category A** | Foreign Language & Social Sciences | | **%** | 100% |
| **Year of study** | 1 | **Semester** | Fall | |
| **ECTS credits** | 3 | **Teaching Units** | 3 | |
| **Name of lecturer(s)** | Foreign Languages Teaching Unit | | | |

## Italian I

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

## Russian I

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

## Introduction to Environmental Physics

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

## Introduction to Information and Communication Technologies

| | | | | |
|---|---|---|---|---|
| **Module code** | **CHM_197** | | | |
| **Module title** | ***Introduction to Information and Communication Technologies*** | | | |
| **Status** | Live | **Type** | Elective | |
| **Category A** | Underpinning Mathematics, Science and Associated engineering | | **%** | 100% |

| Module code | CHM_197 | | |
|---|---|---|---|
| Year of study | 1 | Semester | Fall |
| ECTS credits | 3 | Teaching Units | 3 |
| Name of lecturer(s) | Department of Educational Science & Early Childhood Education | | |

Theory of Democracy: Classical Approaches and Contemporary Problems

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

## 3.3 1st Year – 2nd Semester

Multivariable Calculus and Vector Analysis

| Module code | CHM_201 | | |
|---|---|---|---|
| Module title | ***Multivariable Calculus and Vector Analysis*** | | |
| Status | Live | Type | Compulsory |
| Category A | Underpinning Mathematics, Science and Associated engineering | % | 100% |
| Category B | | % | % |
| Year of study | 1 | Semester | Spring |
| ECTS credits | 7 | Teaching Units | 5 |
| Name of lecturer | Panayiotis Vafeas | | |

| Learning outcomes | CAT | Description |
|---|---|---|
| | A | Knowledge of the new notions in the form of definitions and theorems that concern the basic contents of the module "Multivariable Calculus and Vector Analysis", in order to be able to apply them. |
| | F | Good understanding of the knowledge of the basic applied mathematics for engineers, within the wide area of the differential and integral calculus of many variables, as well as of the vector analysis, which is adequate to his/her science. |
| | I | Ability tocombine and make worthy of the knowledge that he/she acquired to other fields of the theoretical and applied mathematics, in which certain notions and principles of the present module are necessary and usefulto multidisciplinary subjects. |
| | I | Ability to demonstrate knowledge and understanding of essential concepts, principles and applications that are related to the differential and integral calculus of many variables, as well as to the vector analysis. |
| | A | Ability to apply such knowledge to the solution of problems in other fields of the wide conception of theoretical and applied mathematics, related to the science of Chemical Engineering, or to the solution of multidisciplinary problems. |
| | F | Study skills needed for continuing profession development. |

| Module code | CHM_201 | | | |
|---|---|---|---|---|
| Competences Prerequisites | There are no prerequisite modules. It is, however, recommended that students should have the basic knowledge of the differential and integral calculus of one variable, as well as of the linear algebra, which they were taught to the corresponding module "Single Variable Calculus and Linear Algebra". | | | |
| Module content | Functions of many variables, limit, continuity, partial derivative of first or higher order of functions and geometrical meaning. Derivation rules, Schwartz's theorem and directional derivative. Total differential and the conception of differentiation. Composite functions and homogeneous equations, complex forms and basic existence theorems. Jacobian determinant and functional dependence. Taylor's and Maclaurin's mean value theorems. Extremities of functions and bounded extremities, Lagrange's multipliers. Vector analysis, limit, continuity and derivative of vector functions of many variables. Position vector of particle, vector velocity and acceleration. Unit tangential and unit perpendicular vector of curve. Trihedral Frenet–Serret, curvature and turning of curve. Gradient of scalar functions, divergence and rotation of vector functions, their physical meaning and basic vector identities. Laplace's differential operator, harmonic functions and partial differential equations of Helmholtz, wave and diffusion. Irrotational and solenoidal fields, Helmholtz's decomposition theorem. Curvilinear coordinate systems, vector meaning of Jacobian determinant, special orthogonal and curvilinear coordinates, transformations and change of coordinates. Geometrical applications, tangential plane and perpendicular straight line to surface, tangential straight line and perpendicular plane to curve. Multiple integration of functions, double and triple integrals, change of coordinate system and calculation of plane surface areas, of volumes of three–dimensional domains, of mass, of moments of inertia and of gravity center. Curve integrals of the first and of the second kind, calculation of the force work and Green's theorem for the plane. The meaning of the circulation of vector functions, curve integrals independent of the root of integration and applications. Surface integrals and surface parameterization, calculation of the area of arbitrary surface in space. Gauss' and Stokes' integral theorems and their physical meaning. | | | |
| Recommended literature | 1. Π.Μ. Χατζηκωνσταντίνου, "Μαθηματικές Μέθοδοι για Μηχανικούς και Επιστήμονες: Λογισμός Συναρτήσεων Πολλών Μεταβλητών και Διανυσματική Ανάλυση", Εκδόσεις Π.Μ. Χατζηκωνσταντίνου, Πάτρα, 2014. | | | |
| | 2. R.L. Finney, M.D. Weir και F.R. Giordano, "Απειροστικός Λογισμός" (Μετάφραση Μ. Αντωνογιαννάκης), Ίδρυμα Τεχνολογίας & Έρευνας – Πανεπιστημιακές Εκδόσεις Κρήτης, Ηράκλειο, 2012. | | | |
| Teaching and learning methods | **LECTURES** | **RECITATION** | **LAB/PRACTICE** | **PROJECT / HOMEWORK** |
| | 4h/w | 2 h/w | 0 h/w | 0/semester |
| Assessment type | Written Examination | | | |
| Assessment and grading methods | Final written and/or oral exam | | | |
| Instruction Language | Greek | | | |
| Erasmus availability | NO | | | |
| Module URL | http://www.chemeng.upatras.gr/en/content/courses/en/multivariable-calculus-and-vector-analysi | | | |
| Last Amendment | December 2016 | | | |

## Organic Chemistry

| Module code | CHM_212 | | |
|---|---|---|---|
| Module title | ***Organic Chemistry*** | | |
| Status | Live | **Type** | Compulsory |

| **Module code** | **CHM_212** | | | | |
|---|---|---|---|---|---|
| **Category A** | Underpinning Mathematics, Science and Associated engineering | | | **%** | 100% |
| **Category B** | | | | **%** | % |
| **Year of study** | 1 | | **Semester** | Spring | |
| **ECTS credits** | 7 | | **Teaching Units** | 4 | |
| **Name of lecturer** | Eleftherios Amanatides | | | | |
| **Learning outcomes** | **CAT** | **Description** | | | |
| | A | The nomenclature and structure of organic compounds and functional groups | | | |
| | A | The types of intermolecular forces and their effect on the physical properties of organic compounds | | | |
| | A | The main reaction mechanisms of organic molecules as: Nucleophilic Substitution (SN1 and SN2), Nucleophilic Elimination (E1 and E2), Electrophilic Addition Reactions and Markovnikov rule, Free Radical Reactions and Electrophilic Aromatic Substitution Reactions | | | |
| | E | The main mechanisms of synthesis of the most important organic compounds and families | | | |
| **Competences Prerequisites** | There are no prerequisite modules. It is, however, recommended that students should have knowledge of General Chemistry, Reaction Kinetics, Atomic-Molecular Orbitals and Hybridization, Acid – Bases and Basic Thermodynamic Properties (Free Energy Gibbs, Enthalpy, Entropy) | | | | |
| **Module content** | A. Introduction to Organic Chemistry – Chemical Bonds and Molecular Structure<br>B. Organic Compounds – Functional Organic Groups – Nomenclature – Intermolecular Forces – Resonance Structures – InfraRed Spectroscopy of Organic Molecules<br>C. Introduction to Chemical Reactions and Mechanisms – Acid – Bases and their reactions<br>D. Nomenclature and isomerism of alkane and cycloalkanes – Conformations of alkanes and cycloalkanes<br>E. Stereochemistry of alkanes and cycloalkanes<br>F. Nucleophilic Substitution Reactions – Mechanisms SN1 and SN2<br>G. Nucleophilic Elimination Reactions – Mechanisms E1 and E2<br>H. Alkenes/Alkines – Electrophilic Addition Reactions in double/triple bonds - Markovnikov rules<br>I. Mechanisms of Free Radical Reactions and Polymerization<br>J. Aromatic Compounds – Nomenclature – Synthesis and Properties – Mechanism of Electrophilic Substitution Reactions<br>K. Alcohols-Ethers – Aldeydes – Ketones – Synthesis and Properties | | | | |
| **Recommended literature** | 1. Organic Chemistry - Edition: 1st/2012 - Authors: JOHN McMurry - ISBN: 978-960-524-054-7 | | | | |
| | 2. Mechanisms of Organic Chemistry Reactions in aglance - Edition: 1st /2004 - Authors: Moloney Mark G. - ISBN: 978-960-394-245-0 | | | | |
| | 3. Organic Chemistry – 10th Edition 2011- Authors: Graham Solomons and Craig B. Fryhle - ISBN 978-0-470-40141-5 | | | | |
| **Teaching and learning methods** | **LECTURES** | **RECITATION** | **LAB/PRACTICE** | **PROJECT / HOMEWORK** | |
| | 3 h/w | 2 h/w | N h/w | 10/semester | |
| **Assessment type** | Combined | | | | |
| **Assessment and grading methods** | Three written exams during the semester that cover the whole module material. The students that succeed to all three exams (grade > 5) may choose not to participate to the final written and or oral exam. | | | | |
| **Instruction Language** | Greek | | | | |

| | |
|---|---|
| **Module code** | **CHM_212** |
| **Erasmus availability** | YES |
| **Module URL** | https://eclass.upatras.gr/courses/CMNG2116/ |
| **Last Amendment** | December 2016 |

## Laboratory of Analytical Chemistry

| | | | | | |
|---|---|---|---|---|---|
| **Module code** | **CHM_215** | | | | |
| **Module title** | ***Laboratory of Analytical Chemistry*** | | | | |
| **Status** | Live | | **Type** | Compulsory | |
| **Category A** | Chemical Engineering Practice | | | **%** | 100% |
| **Category B** | | | | **%** | % |
| **Year of study** | 1 | | **Semester** | Spring | |
| **ECTS credits** | 3 | | **Teaching Units** | 2 | |
| **Name of lecturer** | Eleftherios Amanatides | | | | |
| **Learning outcomes** | **CAT** | **Description** | | | |
| | B | Principles and methods of the qualitative and quantitative analysis.<br>Ion study and inorganic substances analysis with the liquid-chemical method.<br>Laboratory methods of qualitative semi-microanalysis.<br>Study of the main cations.<br>Theory of titrimetric analysis.<br>Quantitative analysis by titrimetry.<br>Familiarization with simple experimental technics.<br>Realization of laboratory experiments and measurements.<br>Calculations based on experimental data. | | | |
| **Competences Prerequisites** | Analytical Chemistry (CHM_115) | | | | |
| **Module content** | A. Qualitative analysis<br>- Laboratory methods of qualitative semi-microanalysis.<br>- Classification of the cations in analytical groups and subgroups.<br>- Reactions of the cations $Ag^{+}$, $Pb^{2+}$, $Hg_2^{2+}$, $Cu^{2+}$, $Cd^{2+}$, As(III), $Al^{3+}$, $Fe^{3+}$, $Mn^{2+}$, $Co^{2+}$, $Ni^{2+}$, $Zn^{2+}$.<br>- Separation and identification.<br>Laboratory exercises of qualitative analysis.<br>- Analysis of the first analytical group of cations. Ions $Ag^{+}$, $Pb^{2+}$, $Hg_2^{2+}$ (Reactions of the ions, analysis of a known and an unknown solution).<br>- Separation and identification of the ions $Cu^{2+}$, $Cd^{2+}$, As(III) of the second group of cations. (Analysis of a known and an unknown solution).<br>- Separation and identification of the ions $Al^{3+}$, $Fe^{3+}$, $Mn^{2+}$, $Co^{2+}$, $Ni^{2+}$, $Zn^{2+}$ of the third group of cations. (Analysis of a known and an unknown solution).<br>B. Quantitative analysis<br>- Introduction. Errors and statistical treatment of data.<br>- Introduction to the titrimetric methods of analysis.<br>- Neutralization titrations.<br>- Complexation titrations.<br>- Precipitation titrations.<br>- Oxidation/reduction titrations.<br>Laboratory exercises of quantitative analysis<br>- Titrimetric determination of total acid in vinegar and wine.<br>- Titrimetric determination of sodium carbonate.<br>- Titrimetric determination of oxalates.<br>- Titrimetric determination of ascorbic acid. | | | | |

| Module code | CHM_215 | | | |
|---|---|---|---|---|
| | - Titrimetric determination of chlorides.<br>- Titrimetric determination of water hardness. | | | |
| Recommended literature | 1. "Χημική Ισορροπία και Ανόργανη Ποιοτική Ημιμικροανάλυση", Μέρος δεύτερο, Θ. Π. Χατζηιωάννου, Αθήνα, 1996. | | | |
| | 2. "Ποσοτική Ανάλυση", Θ. Π. Χατζηιωάννου, Α. Κ. Καλοκαιρινός και Μ. Τιμοθέου – Ποταμιά, Αθήνα, 2006. | | | |
| | 3. "Εργαστηριακές Μέθοδοι Ποσοτικής Χημικής Ανάλυσης", Ι. Α. Στρατής, Γ. Α. Ζαχαριάδης και Α. Ν. Βουλγαρόπουλος, Εκδόσεις Ζήτη, Θεσσαλονίκη, 2000. | | | |
| Teaching and learning methods | LECTURES | RECITATION | LAB/PRACTICE | PROJECT / HOMEWORK |
| | 0 h/w | 0 h/w | 4 h/w | 0/semester |
| Assessment type | Combined | | | |
| Assessment and grading methods | Evaluation of the laboratory work, 50%, written and/or oral examination, 50% | | | |
| Instruction Language | Greek | | | |
| Erasmus availability | NO | | | |
| Module URL | https://eclass.upatras.gr/courses/CMNG2140 | | | |
| Last Amendment | June 2016 | | | |

## Physics II

| Module code | CHM_230 | | | |
|---|---|---|---|---|
| Module title | ***Physics II*** | | | |
| Status | Live | **Type** | Compulsory | |
| Category A | Underpinning Mathematics, Science and Associated engineering | | **%** | 100% |
| Category B | | | **%** | % |
| Year of study | 1 | **Semester** | Spring | |
| ECTS credits | 7 | **Teaching Units** | 4 | |
| Name of lecturer | Nikolaos Balis | | | |
| Learning outcomes | **CAT** | **Description** | | |
| | A | Ability to apply basic sciences in engineering problems | | |
| | B | Ability to apply experimental and computing methodology, data analysis and interpretation | | |
| | C | Ability to formulate models and apply computing methodologies for solving engineering problems | | |
| Competences Prerequisites | First semester Single Variable Calculus | | | |

| **Module code** | **CHM_230** | | | |
|---|---|---|---|---|
| **Module content** | Electric charge: Electrons, units of charge, conductors – insulators, Coulomb's law<br>Electric field: Definition, calculation of electric field for point charge, thin ring, long charged line, and charged sheet.<br>Gauss's law: Dynamic field lines, Gauss's law and applications, electric field inside conductors<br>Electric potential energy: Gravitational potential energy and work, electric potential energy, electric potential, potential differences, voltage. Electric potential in 3-Dimensions<br>Capacitors: Capacity, flat capacitor, other geometries, dielectrics, capacitor energy<br>Electric current: Ohm's law, electrical resistance, resistivity, electric power, AC currents<br>Magnetism: Introduction, force on a moving charge, cross product, force on current-carrying conductors, torque on closed loops<br>Magnetic fields: Biot-Savart law, infinite current line, circular loop, force between straight conductors, Ampere's law, cylindrical conductors, coils and solenoids, magnetic permeability<br>Electromagnetic Induction: Magnetic flux, Faraday's law, Lentz's law, self-inductance, coil energy<br>Electric Circuits: Circuits with resistors, capacitors and inductors, DC circuits RC and RL, AC circuits RC, RL and RCL<br>Light: Dual nature of light, electromagnetic waves, energy of electromagnetic waves, speed of light, refractive index<br>Geometric Optics, law of reflection, flat and spherical mirrors, law of refraction, total reflection and critical angle, thin lenses<br>Wave Optics: Interference, Young's double slit experiment, diffraction from single slit | | | |
| **Recommended[8] literature** | 1. Physics for scientists and engineers", R.A. Serway, part II | | | |
| | 2. Physics", D. Halliday and R. Resnick", part II | | | |
| | 3. ΦΥΣΙΚΗ ΙΙ (Ηλεκτρομαγνητισμός-Οπτική), Δ. Κουζούδης, Πετρίδης Π. | | | |
| **Teaching and learning methods** | **LECTURES** | **RECITATION** | **LAB/PRACTICE** | **PROJECT / HOMEWORK** |
| | 3 h/w | 1 h/w | 0 h/w | 0/semester |
| **Assessment type** | Combined | | | |
| **Assessment and grading methods** | Written and/or oral examination | | | |
| **Instruction Language** | Greek | | | |
| **Erasmus availability** | YES | | | |
| **Module URL** | https://eclass.upatras.gr/courses/CMNG2165/ | | | |
| **Last Amendment** | December 2016 | | | |

## Physics Laboratory

| **Module code** | **CHM_232** | | | |
|---|---|---|---|---|
| **Module title** | ***Physics Laboratory*** | | | |
| **Status** | Live | **Type** | Compulsory | |
| **Category A** | Chemical Engineering Practice | | **%** | 100% |
| **Category B** | | | **%** | % |
| **Year of study** | 1 | **Semester** | Spring | |
| **ECTS credits** | 3 | **Teaching Units** | 2 | |
| **Name of lecturer** | Dimitris Kouzoudis, Stella Kennou | | | |
| **Learning outcomes** | **CAT[5]** | **Description** | | |

| **Module code** | **CHM_232** | |
|---|---|---|
| | A | Ability to apply basic sciences in engineering problems |
| | B | Ability to apply experimental and computing methodology, data analysis and interpretation |
| | C | Ability to formulate models and apply computing methodologies for solving engineering problems |
| **Competences Prerequisites** | Basic High School Algebra, Geometry and Mathematics | |
| **Module content** | Within the context of this laboratory, the students practice in totally 8 exercises that involve the use of basic and advanced instruments in order to collect experimental data, and the writing of a lab report where the data is processed (experimental errors, capturing data in graphs and identify mathematical relationships). The exercises are:<br>*MECHANICAL*<br>Exercise 1 Basic physical quantities: Measuring length, time and mass<br>*HEAT EXCHANGE*<br>Exercise 2 Solar collector: Measuring heating rates of different surfaces<br>*OPTICS*<br>Exercise 3 Optical lenses: Determination of the focal length of a thin converging lens, magnification<br>Exercise 4 Diffraction: Diffraction pattern from laser light on micro-slits (1 & 2)<br>*ELECTROMAGNETISM*<br>Exercise 5 Photovoltaic cell: Current-Voltage curve of a solar cell, Power<br>Exercise 6 Capacitors: Charging and discharging capacitors in DC circuits<br>Exercise 7 RLC circuit: Resonance of the Electrical current as a function of frequency<br>Exercise 8 Oscilloscope functions: Using the oscilloscope in an AC circuit to measure voltages and frequencies | |
| **Recommended literature** | 1. Physics for scientists and engineers", R.A. Serway, part I & II | |
| | 2. Physics", D. Halliday and R. Resnick", part I & II | |
| | 3. Σημειώσεις Εργαστηρίου, Σ. Κέννου, Δ. Κουζούδης, S. Brosda | |

| **Teaching and learning methods** | **LECTURES** | **RECITATION** | **LAB/PRACTICE** | **PROJECT / HOMEWORK** |
|---|---|---|---|---|
| | 0 h/w | 0 h/w | 4 h/w | 8/semester |
| **Assessment type** | During the semester | | | |
| **Assessment and grading methods** | Delivery of 8 laboratory reports and oral examination | | | |
| **Instruction Language** | Greek | | | |
| **Erasmus availability** | NO | | | |
| **Module URL** | https://eclass.upatras.gr/courses/CMNG2157/ | | | |
| **Last Amendment** | December 2016 | | | |

## Introduction to Science Education

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

English

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

French II

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

German II

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

Italian II

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

Russian II

| | |
|---|---|
| **Module code** | **CHM_295** |
| **Module title** | ***Russian II*** |

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

## Introduction to Educational Sciences

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

## Political Sociology

| | | | | |
|---|---|---|---|---|
| **Module code**[1] | **CHM_297** | | | |
| **Module title**[2] | ***Political Sociology*** | | | |
| **Status** | Live | **Type** | Elective | |
| **Category A** | Foreign Language & Social Sciences | | **%** | 100% |
| **Year of study** | 1 | **Semester** | Spring | |
| **ECTS credits** | 3 | **Teaching Units** | 3 | |
| **Name of lecturer(s)** | Department of Educational Science & Early Childhood Education | | | |

## History of Technology II

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

## 3.4 2nd Year – 3rd Semester

### Ordinary Differential Equations

<table>
<tr><td>Module code</td><td colspan="4">CHM_300</td></tr>
<tr><td>Module title</td><td colspan="4">Ordinary Differential Equations</td></tr>
<tr><td>Status</td><td colspan="2">Live</td><td>Type</td><td>Compulsory</td></tr>
<tr><td>Category A</td><td colspan="2">Underpinning Mathematics, Science and Associated engineering</td><td>%</td><td>100%</td></tr>
<tr><td>Category B</td><td colspan="2"></td><td>%</td><td>%</td></tr>
<tr><td>Year of study</td><td colspan="2">2</td><td>Semester</td><td>Fall</td></tr>
<tr><td>ECTS credits</td><td colspan="2">6</td><td>Teaching Units</td><td>4</td></tr>
<tr><td>Name of lecturer</td><td colspan="4">Spyros Pandis</td></tr>
<tr><td rowspan="3">Learning outcomes</td><td>CAT</td><td colspan="3">Description</td></tr>
<tr><td>A</td><td colspan="3">Application of mathematics in the solution of engineering problems</td></tr>
<tr><td>C</td><td colspan="3">Formulation of mathematical models for the solution of engineering problems</td></tr>
<tr><td>Competences Prerequisites</td><td colspan="4">Calculus and Linear Algebra</td></tr>
<tr><td>Module content[7]</td><td colspan="4">Ordinary differential equations (ODEs) basic concept and ideas. First order ODEs. Separable ODEs. Exact ODEs. Linear ODEs and Bernoulli equation. Homogeneous ODEs. Special form first order ODEs. Integrating factors. Linear second order ODEs. Homogeneous linear second order equations. Second order homogeneous ODEs with constant coefficients. Non-homogeneous equations. Solution by undetermined coefficients. Solution by variation of parameters. Power series solution of differential equations. Legendre's equation. Frobenious method. Bessel's equation and functions. Laplace transforms and their properties. Transforms of step and delta functions. Solution of ODEs by Laplace transform. Systems of ODEs. Transformation of higher order ODEs to a system of first order ODEs. Linear systems and the Wronski determinant. Homogeneous systems with constant coefficients. Graphical representation of solutions and the phase plane. Critical points and their stability. Qualitative solution of nonlinear systems of ODEs.</td></tr>
<tr><td rowspan="2">Recommended literature</td><td colspan="4">1. Σταυρακάκης Ν. (2015) Συνήθεις Διαφορικές Εξισώσεις, Εκδ. Παπασωτηρίου.</td></tr>
<tr><td colspan="4">2. Τραχανάς Σ. (2005) Συνήθεις Διαφορικές Εξισώσεις, Παν. Εκδόσεις Κρήτης.</td></tr>
<tr><td rowspan="2">Teaching and learning methods</td><td>LECTURES</td><td>RECITATION</td><td>LAB/PRACTICE</td><td>PROJECT / HOMEWORK</td></tr>
<tr><td>3 h/w</td><td>2 h/w</td><td>0 h/w</td><td>10/semester</td></tr>
<tr><td>Assessment type</td><td colspan="4">Written Examination</td></tr>
<tr><td>Assessment and grading methods</td><td colspan="4">The results of the final written and/or oral examination are multiplied by a factor based on the performance of the student in the written tests given during the semester.</td></tr>
<tr><td>Instruction Language</td><td colspan="4">Greek</td></tr>
<tr><td>Erasmus availability</td><td colspan="4">NO</td></tr>
<tr><td>Module URL</td><td colspan="4">https://eclass.upatras.gr/courses/CMNG2174/</td></tr>
<tr><td>Last Amendment</td><td colspan="4">December 2016</td></tr>
</table>

## Organic Chemistry Laboratory

| | | | | |
|---|---|---|---|---|
| **Module code** | **CHM-311** | | | |
| **Module title** | ***Organic Chemistry Laboratory*** | | | |
| **Status** | Live | **Type** | Compulsory | |
| **Category A** | Chemical Engineering Practice | | **%** | 100% |
| **Category B** | | | **%** | % |
| **Year of study** | 2 | **Semester** | Fall | |
| **ECTS credits** | 3 | **Teaching Units** | 2 | |
| **Name of lecturer** | Constantinos Tsitsilianis | | | |
| **Learning outcomes** | **CAT** | **Description** | | |
| | A | Ability to organize and perform the synthesis of simple organic molecules. | | |
| | A | Ability to perform various techniques used in organic synthesis such as extraction, filtration, distillation, recrystallization etc. | | |
| | A | Abiity to perform Thin Layer Chromatography. | | |
| **Competences Prerequisites** | Students should have basic knowledge in Organic Chemistry. | | | |
| **Module content** | Synthesis of acetanilide<br>Synthesis of tert- boutylchloride<br>Nitration of acetanilide<br>The Cannizzaro reaction<br>The Claisen- Schmidt reaction<br>Synthesis of oxime of cyclohaxanone<br>Thin Layer Chromatography (TLC) | | | |
| **Recommended literature** | 1. Laboratory Notes | | | |
| | 2. D.L. PAIVA, G.M. LAMPMAN and G.S. KRIZ "Introduction to Organic Laboratory Techniques " , New York (1998). | | | |
| | 3. l.M. HARWOOD, C.J. MOODY and J.M. PERCY "Experimental Organic Chemistry ", London (1995). | | | |
| **Teaching and learning methods** | **LECTURES** | **RECITATION** | **LAB/PRACTICE** | **PROJECT / HOMEWORK** |
| | 0 h/w | 0 h/w | 4 h/w | 0/semester |
| **Assessment type** | Combined | | | |
| **Assessment and grading methods** | Written test before performing the day's experiment (25% of the final grade), Lab report (25% of the final grade), Final written and or oral examination (50% of the final grade). | | | |
| **Instruction Language** | Greek | | | |
| **Erasmus availability** | YES | | | |
| **Module URL** | https://eclass.upatras.gr/courses/CMNG2164/ | | | |
| **Last Amendment** | January 2017 | | | |

## Thermodynamics I

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

| **Module code** | **CHM_220** | | | | | |
|---|---|---|---|---|---|---|
| **Category B** | | | | | **%** | % |
| **Year of study** | 2 | | | **Semester** | Fall | |
| **ECTS credits** | 6 | | | **Teaching Units** | 4 | |
| **Name of lecturer(s)** | Soghomon Boghosian | | | | | |
| **Learning outcomes** | **CAT** | **Description** | | | | |
| | A | Ability to use mathematic tools for deriving Thermodynamics through introduction of new functions and through correlations using partial derivatives | | | | |
| | C | Ability to perform calculations of changes in thermodynamic functions, work and heat in simple (non-chemical) processes | | | | |
| | D | Ability to perform technical calculations in processes involving phase transitions | | | | |
| **Competences Prerequisites** | The students are expected to have a good command of differential equations and integrals. | | | | | |
| **Module content** | FOUNDATION OF THERMODYNAMICS. Thermodynamic systems and variables. Zeroth Law and temperature. Work. Internal Energy and First Law. Heat. Spontaneous and non-spontaneous processes. The Entropy and the Second Law. Reversibility. Clausius inequality. Fundamental thermodynamic equation in internal energy representation. Cyclic processes. Legendre transformations. Enthalpy, Helmholtz free energy, Gibbs free energy. Chemical potential. Euler's theorem, Maxwell relations. Absolute entropy and 3rd Law. Cryogenic temperatures. THERMODYNAMIC PROPERTIES OF PURE HOMOGENIOUS COMPONENTS. Expression of thermodynamic properties through partial derivatives of thermodynamic functions. Specific heat. Heat capacity at constant volume and at constant pressure. Calculations of changes in thermodynamic functions for pure substances. Equations of state of gases. Fugacity. Principle of corresponding states. Critical conditions. Reduced variables. PHASE EQUILIBRIA IN SINGLE COMPONENT SYSTEMS. Molar properties. Phase transitions. Vapor pressure. Clausius-Clapeyron equation. Antoine equation. Entropy and enthalpy changes of phase transitions. First and second order transitions. Lambda transitions. THERMODYNAMICS IN OPEN (FLOW) SYSTEMS. Generalized mass balances. Relation to thermodynamic laws. Applications of mass balances in simple systems. | | | | | |
| **Recommended literature** | 1. J. M. Smith, H. Van Ness, M. M. Abbott, «Introduction to Chemical Engineering Thermodynamics» (translated in greek), A. Tziola & Sons Editions, 2011. | | | | | |
| | 2. Α. Παπαϊωάννου, «Θερμοδυναμική – Τόμος Ι», Εκδόσεις Γκελμπέση, 2007 | | | | | |
| **Teaching and learning methods** | **LECTURES** | | **RECITATION** | **LAB/PRACTICE** | **PROJECT / HOMEWORK** | |
| | 3 h/w | | 2 h/w | 0 h/w | 1/semester | |
| **Assessment type[9]** | Combined | | | | | |
| **Assessment and grading methods** | 1) The student can take two (2) tests on volunteer basis (6th and 13th week of the semester).<br>2) Undertaking of case studies/projects by small (3,4) student groups, on volunteer basis.<br>3) Final exam. The average of the exams (1) – if greater than 5.0 – is considered together with the (optional) project (2) for improving the final module grade. | | | | | |
| **Instruction Language** | Greek | | | | | |
| **Erasmus availability** | YES | | | | | |
| **Module URL** | https://eclass.upatras.gr/courses/CMNG2180/ | | | | | |
| **Last Amendment** | January 2017 | | | | | |

## Computer Programming for Chemical Engineers

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

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

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

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

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

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

## Physical Chemistry

| **Module code** | **CHM_421** | | | |
|---|---|---|---|---|
| **Module title** | ***Physical Chemistry*** | | | |
| **Status** | Live | **Type** | Compulsory | |
| **Category A** | Core Chemical Engineering | | **%** | 100% |
| **Category B** | | | **%** | % |
| **Year of study** | 2 | **Semester** | Fall | |
| **ECTS credits** | 6 | **Teaching Units** | 5 | |
| **Names of lecturers** | Dimitris Kondarides - Vlasis Mavrantzas | | | |

| **Learning outcomes** | **CAT** | **Description** |
|---|---|---|
| | A | After completing this module a student should be able to: Understand the fundamental concepts of quantum mechanics, such as the Schrödinger equation, wave function, quantization, and expectation values |
| | A | Understand the quantum mechanical description of a particle's translational, rotational and vibrational motions and discuss the corresponding wavefunctions and energy levels |
| | A | Grasp the concepts of spin and angular momentum and their quantization, and explain the Zeeman affect and spin-orbit coupling |
| | A | Understand how quantum mechanics can be used to describe the electronic structure of hydrogenic atoms and many-electron atoms |
| | A | Understand the origin of atomic and molecular spectra and discuss the selection rules governing such spectra |
| | A | Predict the thermodynamic properties of a gas in the ideal state from the knowledge of a few literature data for the vibrational frequencies and the geometry of the molecule |
| | A | Apply principles of Statistical Thermodynamics in order to compute equilibrium constants for chemical reactions |
| **Competences Prerequisites** | | |

| Module code | CHM_421 | | | |
|---|---|---|---|---|
| Module content | - Introduction to the Quantum Theory. Classical mechanics. The dynamics of microscopic systems. Quantum mechanical principles.<br>- Techniques and Applications. Translational motion. Vibrational motion. Rotational motion.<br>- Atomic Structure and Atomic Spectra. The structure and spectra of hydrogenic atoms. The structures of many-electron atoms. The spectra of complex atoms. Term symbols and selection rules. The effects of magnetic fields.<br>- Molecular Structure and Molecular Spectra. Molecular orbital theory. The hydrogen molecule-ion. The structures of diatomic molecules. The structures of polyatomic molecules. Rotational spectra of diatomic and polyatomic molecules. Vibrational spectra of diatomic molecules. Introduction to electronic transitions and electronic spectra.<br>- Introduction to statistical thermodynamics. Basic concepts, overall goal. Thermodynamic equilibrium. Equilibrium statistical ensembles.<br>- Canonical partition function. Boltzmann distribution. Canonical statistical ensemble and applications in thermodynamics. Translational, rotational, vibrational, and electronic contributions to the molecular canonical partition function. Fluctuations. 3rd thermodynamic law and residual entropies<br>- Calculation of the equilibrium constants for chemical reactions. Application to dissociation reactions. | | | |
| Recommended literature | 1. P.W. Atkins and J. de Paula, “Physical Chemistry”, 9th Edition, Oxford University Press, 2010 (Greek translation, 2014). | | | |
| | 2. Στέφανος Τραχανάς, “Στοιχειώδης Κβαντική Φυσική”, Πανεπιστημιακές Εκδόσεις Κρήτης, 2012. | | | |
| | 3. Β. Μαυραντζάς, “Στατιστική Θερμοδυναμική” (Statistical Thermodynamics), Hellenic Open University, Patras (2001). | | | |
| Teaching and learning methods | **LECTURES** | **RECITATION** | **LAB/PRACTICE** | **PROJECT / HOMEWORK** |
| | 4 h/w | 2 h/w | 0 h/w | 0/semester |
| Assessment type | Combined | | | |
| Assessment and grading methods | 3 written exams during the semester, final written and/or oral exam | | | |
| Instruction Language | Greek | | | |
| Erasmus availability | NO | | | |
| Module URL | https://eclass.upatras.gr/courses/CMNG2172/ | | | |
| Last Amendment | December 2016 | | | |

## English - Technical Terms for Chemical Engineers

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

## 3.5 2nd Year – 4th Semester

### Partial Differential Equations

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

| **Module code** | **CHM_402** | | | |
|---|---|---|---|---|
| | to eigenfunctions, fundamental solution and integral representations of homogeneous and non homogeneous problem. Hyperbolic type equations (wave equation), principal concepts of wave propagation, finite and infinite string. Problems of parabolic and hyperbolic type with initial and boundary conditions, applications to physics with the method of separating variables and solution through Fourier's in space and Laplace's in time integral transforms. | | | |
| **Recommended literature** | 1. Π.Μ. Χατζηκωνσταντίνου, "Μαθηματικές Μέθοδοι για Μηχανικούς και Επιστήμονες: Μερικές Διαφορικές Εξισώσεις, Σειρές Fourier& Προβλήματα Συνοριακών Τιμών – Μιγαδικές Συναρτήσεις", Εκδόσεις Π.Μ. Χατζηκωνσταντίνου, Πάτρα, 2014. | | | |
| | 2. Σ. Τραχανάς, "Μερικές Διαφορικές Εξισώσεις", Ίδρυμα Τεχνολογίας & Έρευνας – Πανεπιστημιακές Εκδόσεις Κρήτης, Ηράκλειο, 2009. | | | |
| **Teaching and learning methods** | **LECTURES** | **RECITATION** | **LAB/PRACTICE** | **PROJECT / HOMEWORK** |
| | 2h/w | 1 h/w | 0 h/w | 0/semester |
| **Assessment type** | Written Examination | | | |
| **Assessment and grading methods** | A final written exam is given in the end of the sementer (100% of the final grade) | | | |
| **Instruction Language** | Greek | | | |
| **Erasmus availability** | NO | | | |
| **Module URL** | http://www.chemeng.upatras.gr/en/content/courses/en/partial-differential-equations | | | |
| **Last Amendment** | December 2016 | | | |

## Physical Chemistry Laboratory

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

| Module code | CHM_521 | | | |
|---|---|---|---|---|
| Module content | 1) Conductometric titrations. Conductivity mechanisms in ionic solutions. Conductivity and equivalent conductivity.<br>2) Electrochemical Analysis. Electrochemical reaction. Electrochemical cell. Electrolysis.<br>3) Determination of diffusion potential. Ionic mobilitiesTransport numbers. Galvanic cells. Nernst equation.<br>4) Ultraviolet-Visible Spectrophotometry (UV/VIS). Electronic absorption spectra. Beer-Lambert law. Molar extinction coefficient.<br>5) JOULE-THOMSON expansion. Real (non-ideal) gases. Liquification. Cryogenics.<br>6) Vapor-Liquid equilibria. Raoult law. Ideal and non-ideal solutions of volatile liquids. Azeotropic composition.<br>7) Freezing point depression. Equilibrium between a solution and a solid component. Determination of molar mass of unknown component.<br>8) Partial molar volumes. Non ideal solutions. Significance and determination of partial molar properties | | | |
| Recommended literature | 1. P. Atkins, J. de Paula, "Physical Chemistry", 9th Edition, Oxford University Press, 2014 | | | |
| Teaching and learning methods | LECTURES | RECITATION | LAB/PRACTICE | PROJECT / HOMEWORK |
| | 0 h/w | 0 h/w | 4 h/w | 8/semester |
| Assessment type | Combined | | | |
| Assessment and grading methods | 1) Two (2) mandatory tests, during the 6th and 13th week of the semester (50%); 2) Oral interview while performing of the laboratory experiment (10%); 3) Written report (40%). | | | |
| Instruction Language | Greek | | | |
| Erasmus availability | NO | | | |
| Module URL | https://eclass.upatras.gr/courses/CMNG2161/ | | | |
| Last Amendment | January 2017 | | | |

## Numerical Analysis

| Module code | CHM_660 | | | |
|---|---|---|---|---|
| Module title | ***Numerical Analysis*** | | | |
| Status | Live | **Type** | Compulsory | |
| Category A | Underpinning Mathematics, Science and Associated engineering | | **%** | 100% |
| Category B | Choose Module Category B | | **%** | % |
| Year of study | 2 | **Semester** | Spring | |
| ECTS credits | 8 | **Teaching Units** | 5 | |
| Name of lecturer | Yannis Dimakopoulos | | | |
| Learning outcomes | **CAT** | **Description** | | |
| | A | Ability for deep understanding of the fundamental numerical methods. | | |
| | B | Ability to recognize the advantages and disadvantages of each method in order to decide the most convenient in use on application basis | | |
| | B | Ability to use specific software in order to develop the necessary applications | | |
| | A | Ability to analyze and interpret data | | |
| Competences Prerequisites | There are no prerequisite modules. It is, however, recommended that students should have a good knowledge of Mathematics (Calculus, Linear Algebra, Differential Equations) as well as fundamental skills on Scientific Programming) | | | |

| Module code | CHM_660 | | | |
|---|---|---|---|---|
| | | | | |
| Module content | Introduction (discretization, error analysis), Numerical Differentiation (forward, backward and central differences), Numerical Integration (trapezoid rule, Simpson rule, Newton-Cotes formulae), Interpolation/Extrapolation (Taylor, Lagrange polynomials), Numerical solution of algebraic equations (trial & error, bisection, Newton-Raphson), Numerical solution of linear systems (Gauss, Jacobi, Gauss-Seidel), Numerical Integration of Ordinary Differential Equations (Euler, Runge-Kutta), Finite Differences, Special Topics, Non-linear systems. | | | |
| Recommended literature | 1. Chapra S. & Canale R., "Numerical Methods for Engineers" (6th ed.), McGraw-Hill (2012) | | | |
| | 2. Pozrikidis C., "Numerical Computation in Science and Engineering", Oxford University Press, New York (1998). | | | |
| | 3. Daoutidis P., Mastrogeorgopoulos, S. & Sidiropoulou, E. "Numerical Methods for engineering problems", Anikoula Ed., Thessaloniki (2010), in Greek. | | | |
| Teaching and learning methods | **LECTURES** | **RECITATION** | **LAB/PRACTICE** | **PROJECT / HOMEWORK** |
| | 3 h/w | 1 h/w | 3 h/w | 6/semester |
| Assessment type | Combined | | | |
| Assessment and grading methods | 1. Laboratory problem-solving by the students (35% of the final grade).<br>2. Written examination (open-book, 65% of the final grade). | | | |
| Instruction Language | Greek | | | |
| Erasmus availability | NO | | | |
| Module URL | https://eclass.upatras.gr/modules/auth/opencourses.php?fc=59 | | | |
| Last Amendment | January 2017 | | | |

## Thermodynamics II

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

| | |
|---|---|
| **Module code** | **CHM_320** |
| **Module content** | Partial molar properties. Gibbs-Duhem equation. Ideal and real gas mixtures. Lewis-Randall rule. Equilibria of reactions involving gases. Stoichiometry. Direction and extent of reaction. General condition of equilibrium. Equilibrium constant. Standard Gibbs free energy of reaction. Van't Hoff relation. Enthalpy of reaction. General relations for the temperature dependence of Kp and ΔG. Other forms of the equilibrium constant. Standard thermodynamic functions (G, H, S) of formation. Hess' Law. Reaction equilibria involving gases with immiscible liquids and solids. Number of independent reactions. Maximum attainable yield. Le Chatelier's principle. Gibbs' Phase Rule. Degrees of freedom. Effect of inert gas on the vapor pressure of a component. General properties of solution. Partial pressure – composition relations. Raoult's and Henry's Law. Deviations. Duhem-Margules equation. Solubility. Ideal solutions. The chemical potential model for ideal solutions. Thermodynamic properties of mixing in ideal solutions. Tand P dependence of the Henry's law constant. Equilibrium between ideal solution and pure crystalline component. Freezing point depression. Boiling point elevation. Osmotic pressure. Non ideal solutions and the chemical potential model. Activity coefficients. Gibbs – Duhem equation in representation of activity coefficients. Activity coefficients of solutes. Activity. Excess properties. |
| **Recommended literature** | 1. P. Atkins, J. de Paula, "Physical Chemistry", 9th Edition, Oxford University Press, 2014 |
| | 2. Y.A. Cengel, M. A. Boles, «ThermodynamicsQ An Engineering Approach» 8th Edition (in Greek), A. Tziola & Sons Ed., 2016 |

| **Teaching and learning methods** | **LECTURES** | **RECITATION** | **LAB/PRACTICE** | **PROJECT / HOMEWORK** |
|---|---|---|---|---|
| | 4 h/w | 1 h/w | 0 h/w | 2/semester |

| | |
|---|---|
| **Assessment type** | Combined |
| **Assessment and grading methods** | 1) The student can take two (2) tests on volunteer basis (6th and 13th week of the semester).<br>2) Undertaking of case studies/projects by small (3,4) student groups, on volunteer basis.<br>3) Final exam. The average of the exams (1) – if greater than 5.0 – is considered together with the (optional) project (2) for improving the final module grade. |
| **Instruction Language** | Greek |
| **Erasmus availability** | YES |
| **Module URL** | https://eclass.upatras.gr/courses/CMNG2181/ |
| **Last Amendment** | January 2017 |

## Mechanics of Materials

| | | | | |
|---|---|---|---|---|
| **Module code** | **CHM_582** | | | |
| **Module title** | ***Mechanics of Materials*** | | | |
| **Status** | Live | **Type** | Compulsory | |
| **Category A** | Core Chemical Engineering | | **%** | 100% |
| **Category B** | Choose Module Category B | | **%** | % |
| **Year of study** | 2 | **Semester** | Spring | |
| **ECTS credits** | 5 | **Teaching Units** | 4. | |
| **Name of lecturer** | Costas Galiotis | | | |
| **Learning outcomes** | **CAT[5]** | **Description** | | |
| | A | Understand the concepts and principles applied to members under various loadings and the effects of these loadings | | |

<table>
<tr><td>Module code</td><td colspan="4">CHM_582</td></tr>
<tr><td rowspan="2"></td><td>B</td><td colspan="3">Analyze structural members subjected to tension, compression, torsion, bending and combined stresses using the fundamental concepts of stress, strain and elastic behavior of materials.</td></tr>
<tr><td>D</td><td colspan="3">Analyze cylindrical vessels subjected to pressure.</td></tr>
<tr><td>Competences Prerequisites</td><td colspan="4">Students should have knowledge of mathematics and physics.</td></tr>
<tr><td>Module content</td><td colspan="4">A. ELEMENTS OF STATICS<br>(Non-Deformable Bodies)<br>1. Introduction. Forces. Forces synthesis and equilibrium. Torque. Solid body balance and equilibrium equations.<br>2. Trusses. Elements of vector analysis. Working with vectors. Trusses. Statically Indeterminate truss<br>3. Diagrams N, Q, M. Type of vectors and methods of joint. Beam Stress state. Uniaxial - Shear.<br><br>B. STRENGTH OF MATERIALS (Deformable Bodies)<br>4. Introduction in strength of materials. Axial, plane, general stresses. Hooke's Law. Generalized Hooke's law. Superposition principle. Shear. Thermal stresses. Static problems.Mechanical behaviour of metals, ceramics and polymers.<br>5. Fracture, Plastic Yielding and Fatigue of Materials<br>Failure in tension and compression. General principles of fracture mechanics. Plastic yielding. Models of yielding. Fatigue of materials. Models describing fatigue behaviour.<br>6. Thermal stresses and strains<br>Thermal effects. Volumetric change under axial loading. Thermal expansion and calculation of stresses in various temperatures.<br>7. Bending and Torsion<br>8. Axial loading and Bending. Geometric centres, moment of inertia. Bending. Maximum hoop stress. Beam dimensioning during bending. Shear-bending. Axial loading and Torsion.Torsion of thin-walled vessels. Torsion of round sectional bar. Static problems of torsion.<br>9. Thin-walled pressure vessels<br>Stresses and deformations. Failure. Volumetric behaviour. Design problems.<br><br>Keywords: trusses, forces, diagrams N, Q, M, shear, thermal stresses, Hooke Law, thin-walled tubes, torque, torsion, bending</td></tr>
<tr><td rowspan="2">Recommended literature</td><td colspan="4">1. P.A. Vouthounis, Technical Mechanics, Edit. 2011. ISBN: 978-960-85431-7-1</td></tr>
<tr><td colspan="4">2. F.P.Beer, E.R. Johnston,Jr, John T. DeWolf, D.F. Mazurek, Edit. Tziola, 2012. ISBN: 978-960-418-381-4</td></tr>
<tr><td rowspan="2">Teaching and learning methods</td><td>LECTURES</td><td>RECITATION</td><td>LAB/PRACTICE</td><td>PROJECT / HOMEWORK</td></tr>
<tr><td>3 h/w</td><td>1 h/w</td><td>0 h/w</td><td>0/semester</td></tr>
<tr><td>Assessment type</td><td colspan="4">Written Examination</td></tr>
<tr><td>Assessment and grading methods</td><td colspan="4">Written examination (100% of the final mark)</td></tr>
<tr><td>Instruction Language</td><td colspan="4">Greek</td></tr>
<tr><td>Erasmus availability</td><td colspan="4">YES</td></tr>
<tr><td>Module URL</td><td colspan="4">https//eclass.upatras.gr/courses/CMNG2114/</td></tr>
<tr><td>Last Amendment</td><td colspan="4">September 2016</td></tr>
</table>

## Statistics for Engineers

| | | | | |
|---|---|---|---|---|
| **Module code** | **CHM_202** | | | |
| **Module title** | ***Statistics for Engineers*** | | | |
| **Status** | Live | **Type** | Compulsory | |
| **Category A** | Underpinning Mathematics, Science and Associated engineering | | **%** | 100% |
| **Category B** | Choose Module Category B | | **%** | % |
| **Year of study** | 2 | **Semester** | Spring | |
| **ECTS credits** | 3 | **Teaching Units** | 3. | |
| **Name of lecturer** | Spyros Pandis | | | |
| **Learning outcomes** | **CAT** | **Description** | | |
| | A | Application of statistics to the solution of engineering problems | | |
| | B | Application of statistical data analysis | | |
| | C | Formulation and application of statistical models in engineering problems | | |
| **Competences Prerequisites** | Calculus | | | |
| **Module content** | Data analysis. Fundamental principles of probability theory. Basic theorems of probability theory. Combinatorial analysis. Discrete random variables and their distributions. Continuous random variables. Parameters of probability distributions. Normal distribution. Binomial distribution. Hypergeometric distribution. Poisson distribution. Confidence intervals. t-distribution and χ2 distribution. Hypothesis testing. Linear regression. | | | |
| **Recommended literature** | 1. Ζιούτας Γ. (2004) Πιθανότητες και Στοιχεία Στατιστικής για Μηχανικούς, εκδ. Ζήτη. | | | |
| | 2. Ρασσιάς Ι. (2003) Θεωρία Πιθανοτήτων και Στατιστικής, εκδ. Συμμετρία. | | | |
| **Teaching and learning methods** | **LECTURES** | **RECITATION** | **LAB/PRACTICE** | **PROJECT / HOMEWORK** |
| | 2 h/w | 1 h/w | 0 h/w | 6 /semester |
| **Assessment type** | Written Examination | | | |
| **Assessment and grading methods** | The grade of the final exam is multiplied by a factor based on the performance of the student in the tests given randomly during the semester. | | | |
| **Instruction Language** | Greek | | | |
| **Erasmus availability** | NO | | | |
| **Module URL** | https//eclass.upatras.gr/courses/CMNG2176/ | | | |
| **Last Amendment** | December 2016 | | | |

## 3.6 3rd Year – 5th Semester

### Fluid Mechanics

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

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

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

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

## Polymer Science and Technology

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

| Module code | CHM_570 |
|---|---|
| Module content | Nomenclature of macromolecules, degree of Polymerization, Average molecular weights, classification of polymerization reactions, macromolecular architecture, copolymers, isomerism of macromolecules. Chemistry of step-growth polymerization, Monomers and general schemes of step-growth reactions, crosslinked polymers (thermosettings). Kinetics of step-growth polymerization, kinetics of gelation reactions. Chemistry of chain-growth radical polymerization, controlled free radical polymerization. Kinetics of chain-growth polymerization, Kinetic scheme (initiation, propagation, termination) polymerization rate, evaluation of kinetic constants, degree of polymerization of products DPn, DPw versus monomer conversion relationships, the Trommsdorff effect, influence of chain transfer reactions on the kinetic equation. Kinetics of radical copolymerization, Kinetic scheme, reactivity ratios. Statistical thermodynamics of macromolecular solutions, lattice model, Flory Huggins theory, entropy of mixing of athermal solutions, enthalpy of mixing and chemical potentials of regular solutions, thermodynamics of real polymer solutions the interaction parameter. Phase equilimbria, solubility, Phase diagrams, polymer/solvent binary systems, polymeric blends. Dilute polymer solutions and characterization methods of polymers, osmotic pressure-determination of Mn, viscometry-determination of Mv, gel permeation chromatography. Solid state properties of macromolecules<br>Crystallization state, kinetics of crystallization, melting, amorphous state, glass transition temperature, free volume theory. Mechanical properties. |
| Recommended literature | 1. «Συνθετικά Μακρομόρια, Βασική Θεώρηση», Α.Ντόντος, Εκδ. Κωσταράκης, Αθήνα 2012. |
| | 2. «Επιστήμη και Τεχνολογία Πολυμερών», Κ. Παναγιώτου, Εκδ. ΠΗΓΑΣΟΣ, Θεσσαλονίκη. |
| | 3. "Polymer Chemistry" P.C.Hiemenz, T.P. Lodge 2nd Ed. CRC Press, New York 2007. |

| Teaching and learning methods | LECTURES | RECITATION | LAB/PRACTICE | PROJECT / HOMEWORK |
|---|---|---|---|---|
| | 3 h/w | 1 h/w | N h/w | 1/semester |

| | |
|---|---|
| Assessment type | Combined |
| Assessment and grading methods | Written assay after the completion of the first five chapters (for marks over 5 there is a bonus that will be added to the final exams mark). Final written examination. |
| Instruction Language | Greek |
| Erasmus availability | YES |
| Module URL | https://eclass.upatras.gr/courses/CMNG2154/ |
| Last Amendment | January 2017 |

## Technical Thermodynamics and Balances

| Module code | CHM_540 | | | |
|---|---|---|---|---|
| Module title | ***Technical Thermodynamics and Balances*** | | | |
| Status | Live | Type | Compulsory | |
| Category A | Core Chemical Engineering | | % | 100% |
| Category B | Choose Module Category B | | % | % |
| Year of study | 3 | Semester | Fall | |
| ECTS credits | 6 | Teaching Units | 4 | |
| Name of lecturers | Spyridon Ladas, Dimitrios Spartinos | | | |

| Learning outcomes | CAT | Description |
|---|---|---|
| | A | Apply principles and methods of General Chemistry, Physical Chemistry , Classical Thermodynamics and Calculus in solving Chemical Engineering Problems. |

| Module code | CHM_540 | |
|---|---|---|
| | C | Ability to create models of any process based on properly chosen control volumes and input/output streams, and to subsequently solve them using the corresponding material, energy and entropy balances. |
| | D | Mastering the use of key chemical engineering concepts, like model formulation and property-balances application thereon, in diverse technological areas. |
| | G | Ability to appreciate the impact of engineering calculations (and the uncertainties thereof), when applied on problems involving critical economic, environmental and health/safety issues, via selected worked out examples. |
| Competences Prerequisites | Students are expected to have basic knowledge from Mathematics, General and Inorganic Chemistry, Organic Chemistry as well as Thermodynamics I & II courses. | |
| Module content | 1. Brief summary of the concept of Balances: Importance of Balances for Chemical Engineers - Introduction to technical calculations.<br>2. Material Balances: Applications in simple and complex systems with and without chemical reactions. Industrial applications (Recycle – Bypass - Purge).<br>3. Calculations of thermodynamic property changes: Empirical equations of state. Multiparametric Corresponding States correlations (Lee- Kessler and Pitzer correlations - Nelson-Obert charts). Enthalpy and entropy change calculations from equations of state and specific heat data. Thermodynamic charts, Steam Tables. Calculating ΔH, ΔS using Corresponding States correlations to evaluate residual thermodynamic properties.<br>4. Material and Energy Balances: Applications in systems with and without chemical reactions.<br>5. Combining material, energy and entropy balances. Thermodynamic process analysis :Lost work and thermodynamic efficiency. Applications in energy generation, refrigeration, liquefaction, chemical processes. | |
| Recommended literature | 1. D.M.Himmelblau, J.B.Riggs, “Basic Principles and Calculations in Chemical Engineering”, 8th Edition, (Transl. in Greek by G. Marnelos), Edit.Tziola (2015) | |
| | 2. J.M.Smith , H.C. van Ness, M.M. Abbott “Introduction to Chemical Engineering Thermodynamics”, 7th Edition in SI Units, (Transl. in Greek by A. Vronteli, P.Tsiakaras), Edit . Tziola (2011) | |
| | 3. Y.A. Cengel, M.A.Boles, “Thermodynamics: An Engineering Approach”, 7th Edition in SI Units (Transl. in Greek by P.Tsiakaras, E.Kotsialos), Edit. Tziola (2011) | |

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

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

## Materials Science

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

| Module code | CHM_381 | | | | |
|---|---|---|---|---|---|
| Category B | Choose Module Category B | | | % | % |
| Year of study | 3 | | Semester | Fall | |
| ECTS credits | 6 | | Teaching Units | 4 | |
| Name of lecturers | Stella Kennou, Dimitris Kouzoudis | | | | |
| Learning outcomes | CAT | Description | | | |
| | A | Know the fundamental science and engineering principles relevant to materials. | | | |
| | A | Understand the relationship between nano/microstructure, characterization, properties and processing and design of materials. | | | |
| | A | Have the fundamental experimental and computational skills as engineers in materials. | | | |
| | A | To be able to apply general math, science and engineering skills to the solution of engineering problems. | | | |
| | A | To be able to apply core concepts in Materials Science to solve engineering problems. | | | |
| | A | To be able to select materials for design and construction. | | | |
| | D | Possess the skills and techniques necessary for modern materials engineering practice. | | | |
| Competences Prerequisites | There are no prerequisites for this module. Students should have basic knowledge of mathematics and physics. | | | | |
| Module content | Introduction<br>Materials Science description. The Era of Materials. The Greatest Materials Moments. Environmental and Other Effects. Examples<br>Atomic Structure and Bonding<br>Atomic bonding. Periodic table of elements. Atomic bonding and properties of Materials. Intermetallic Compounds. Examples.<br>Atomic and Ionic Arrangements.<br>Crystal structure. Atomic arrangements. Structure of metals. FCC, HCP, BCC structures. Structure of ceramics. Points, Directions, and Planes in the Unit Cell. Allotropic or Polymorphic Transformations. Examples<br>Imperfections in Solids<br>Dislocations. Point defects. Grain boundaries. Examples.<br>Atomic movement<br>Diffusion. Diffusion Mechanisms. Steady-State Diffusion. Nonsteady-State Diffusion. 1st and 2nd Fick's laws. Examples.<br>Phase (equilibrium) diagrams<br>Introduction. Phases. Microstructure. Phase equilibria. Isomorphic and Eutectic binary alloys. Eutectic, eutectoid, peritictic reactions. Phase rule (Gibbs). The iron–carbon system. Examples.<br>Phase Transformations<br>The Kinetics of Solid-State Reactions. Benite. Martensite. Isothermal Transformation Diagrams. Continuous Cooling Transformation Diagrams. Examples<br>Electrical properties - Conductors, Insulators and Semiconductors<br>Electrical conductivity - Electrical constant. Piezoelectricity, Intrinsic semiconductors, p and n type semiconductors, transistors, Integrated circuits, Transistors, MEMS. Examples<br>Optical properties<br>Interaction of light with solids - Reflectivity, Polarization, Optoelectrical devices. Examples<br>Magnetic properties<br>Magnetic fields, Induction, Magnetization, -Induction- Diamagnetism, Paramagnetism, Ferromagnetism, Magnetic materials and applications. Examples<br>Thermal properties<br>Metals, Ceramics and Polymers- Applications. Examples<br>***Keywords***: Material Science, Material Engineering, | | | | |

| Module code | CHM_381 | | | |
|---|---|---|---|---|
| Recommended literature | 1. D. Chrisoulakis, D. I. Pantelis, Science and Engineering of Metallic Materials, Edit. Papasotiriou, 2003. ISBN: 960-7510-39-9 | | | |
| | 2. W.D. Callister, Jr., Science and Engineering of Materials, Edit. Tziola, 2004. ISBN: 960-8050-90-1 | | | |
| | 3. R. Askeland, The Science and Engineering of Materials, Edit. Chapman & Hall, 1996. ISBN: 0-412-53910-1 | | | |
| Teaching and learning methods | **LECTURES** | **RECITATION** | **LAB/PRACTICE** | **PROJECT / HOMEWORK** |
| | 3 h/w | 2 h/w | 0 h/w | 0/semester |
| Assessment type | Written Examination | | | |
| Assessment and grading methods | | | | |
| Instruction Language | Greek | | | |
| Erasmus availability | NO | | | |
| Module URL | http://www.chemeng.upatras.gr/en/content/courses/en/materials-science | | | |
| Last Amendment | January 2017 | | | |

## Microbiology

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

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

## Materials Laboratory

| | | | | |
|---|---|---|---|---|
| **Module code** | **CHM_481** | | | |
| **Module title** | ***Material Laboratory*** | | | |
| **Status** | Live | **Type** | Compulsory | |
| **Category A** | Chemical Engineering Practice | | **%** | 100% |
| **Category B** | Choose Module Category B | | **%** | % |
| **Year of study** | 3 | **Semester** | Fall | |
| **ECTS credits** | 3 | **Teaching Units** | 2 | |
| **Name of lecturer** | Victor Stivanakis | | | |
| **Learning outcomes** | **CAT** | **Description** | | |
| | A | Understanding of the principles and procedures which concern:<br>-Treatment and preparation of metallic specimens for optical observation.<br>-Processes required for the hardening of metals with desirable results.<br>-Hardness measurements of the metallic samples surfaces<br>-Thermal analysis of metals and their alloys | | |

<table>
<tr><td>Module code</td><td colspan="4">CHM_481</td></tr>
<tr><td rowspan="4"></td><td></td><td colspan="3">-Construction of phase diagrams using experimental data</td></tr>
<tr><td>B</td><td colspan="3">Ability to:<br>- combine theoretical fundamentals (from the module “Materials Science ”) with results obtained during the experiments and analyses in order to program processes (thermal, mechanical, etc.) with desired results (technological properties of metals),<br>- estimate the thermal and mechanical prehistory of the metallic samples with macroscopic observations</td></tr>
<tr><td>B</td><td colspan="3">Ability to use equipment and tools for sample preparation (cutting devices, hydraulic mounting press, polishing, etching, laboratory muffle furnaces, temperature measurement devices) as well as to use optical devices (microscopes, stereoscopes)</td></tr>
<tr><td>K</td><td colspan="3">Ability to cooperate with others and to present and discuss results within a group</td></tr>
<tr><td>Competences Prerequisites</td><td colspan="4">There are no prerequisite modules. The students should have a basic knowledge of Material Science I.</td></tr>
<tr><td>Module content</td><td colspan="4">– Preparation of metallic specimens for metallographic observation.<br>– Sectioning of metallographic samples by a discotom.<br>– Hot mounting of the sample in the appropriate resin.<br>– Stepwise polishing of mounted sample.<br>– Chemical etching of the metallic sample.<br>– Observation of a metallic cross-section by optical microscope. Drawing conclusions on the type and the structure of the observed sample.<br>– Thermal analysis of metals and their alloys.<br>– Methods for temperature measurements.<br>– Construction of a two component phase diagram.<br>– Hardening of plain and alloyed steels with rapid local heating and cooling device Jomini (Martensitic transition)<br>– Influence of the hardening on the crystalline structure and the technological properties.<br>– Hardness measurement on metal samples and construction of diagrams.<br>– Conclusions and comparison of the results among the plain steel and their alloys.<br>– Correlation of the obtained measurement results with the CCT (continuous cooling transformation) diagrams (cooling rate, hardness).</td></tr>
<tr><td rowspan="4">Recommended literature</td><td colspan="4">1. Instructor’s notes</td></tr>
<tr><td colspan="4">2. “Μεταλλογνωσία” (Κράματα, Μέταλλα, Βιομηχανικά Κράματα), Κ. Κονοφάγος</td></tr>
<tr><td colspan="4">3. “Εισαγωγή στην Επιστήμη των Υλικών- Μεταλλογνωσία”, Π. Νικολόπουλος.</td></tr>
<tr><td colspan="4">4. “Materials Science and Engineering: An Introduction” William D. Callister.</td></tr>
<tr><td rowspan="2">Teaching and learning methods</td><td>LECTURES</td><td>RECITATION</td><td>LAB/PRACTICE</td><td>PROJECT / HOMEWORK</td></tr>
<tr><td>0 h/w</td><td>0 h/w</td><td>4 h/w</td><td>0/semester</td></tr>
<tr><td>Assessment type</td><td colspan="4">Combined</td></tr>
<tr><td>Assessment and grading methods</td><td colspan="4">1. Oral presentation by each group of students (70% of the final mark).<br>2. Tests and participation in the laboratory (30% of the final mark).</td></tr>
<tr><td>Instruction Language</td><td colspan="4">Greek</td></tr>
<tr><td>Erasmus availability</td><td colspan="4">NO</td></tr>
<tr><td>Module URL</td><td colspan="4">https://eclass.upatras.gr/courses/CMNG2156/</td></tr>
<tr><td>Last Amendment</td><td colspan="4">January 2017</td></tr>
</table>

## 3.7 3rd Year – 6th Semester

### Heat Transfer

| | | | | |
|---|---|---|---|---|
| **Module code** | **CHM_650** | | | |
| **Module title** | ***Heat Transfer*** | | | |
| **Status** | Live | **Type** | Compulsory | |
| **Category A** | Core Chemical Engineering | | **%** | 100% |
| **Category B** | Choose Module Category B | | **%** | % |
| **Year of study** | 3 | **Semester** | Spring | |
| **ECTS credits** | 6 | **Teaching Units** | 4 | |
| **Name of lecturer** | John Tsamopoulos | | | |
| **Learning outcomes** | **CAT** | **Description** | | |
| | A | The ability to comprehend the basic principles and modes of heat transfer and the physical significance and importance of the relevant dimensionless numbers for solving heat transfer problems.<br>The ability to develop microscopic and macroscopic heat transfer balances in steady and transient state. | | |
| | C | Understand how to simplify practical and complicated heat transfer problems and solve them primarily analytically, but also by using appropriate numerical methods | | |
| | D | Understand how to simplify complex heat transfer phenomena to simpler ones, to develop and simplify heat flow balances, to determine suitable auxiliary conditions and solve the final equations.<br>Understand the difference between heat conduction, convection (forced & free) and radiation. The required in each case assumptions and the procedure to solve the corresponding problems. | | |
| **Competences Prerequisites** | CHM_102, CHM_201, CHM_300, CHM_402, CHM_130, CHM_230, CHM_220, CHM_320, CHM_550 | | | |
| **Module content** | INTRODUCTION. Mechanisms of heat transfer, examples. Fourier's law for heat conduction, Newton correlation in heat convection. General differential equation for heat transfer. Boundary and initial conditions in heat transfer problems. The Biot number.<br>STEADY 1D HEAT CONDUCTION. Heat generation in the bulk and on material interfaces. Addition of heat resistances in various geometries. The fin approximation.<br>STEADY HEAT CONDUCTION IN 2D. Exact solutions via separation of variables. Shape factor. Solution using charts and polynomial approximations.<br>TRANSIENT HEAT CONDUCTION IN ONE OR MORE DIMENSIONS. The similarity method. Solution using separation of variables. Approximate solutions.<br>INTRODUCTION TO HEAT CONVECTION. Forced and free convection. Dimensionless analysis and similarity. Examples admitting simple analytical solution. Approximate correlations in heat convection. Analogies between heat, mass and momentum transfer. The Nusselt, Graetz, Prandtl and Peclet numbers.<br>FORCED CONVECTION INSIDE DUCTS AND AROUND BODIES. Convection over a surface, the boundary layer in heat transfer. Entrance length in ducts. Developing and developed flow with respect to hydraulic and heat characteristics. Using polynomials to obtain approximate solutions. Correlations and diagrams to solve problems. Convection in turbulent flow.<br>FREE CONVECTION. Free convection around bodies. Coupled free and forced convection. The Grashof and Rayleigh numbers.<br>HEAT RADIATION. Radiation intensity. Radiation formula by PLANCK. Law by STEFAN-BOLTZMANN. Radiation and absorption. The black and brown body. Radiation between brown bodies. Gas radiation. | | | |
| **Recommended literature** | 1. Μεταφορά Θερμότητας και Μάζας, Ασημακόπουλος, Λυγερού, Αραμπατζής, Παπασωτηρίου | | | |

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

## Mass Transfer

| Module code | CHM_755 | | | |
|---|---|---|---|---|
| Module title | ***Mass Transfer*** | | | |
| Status | **Live** | **Type** | Compulsory | |
| Category A | Core Chemical Engineering | | **%** | 100% |
| Category B | Choose Module Category B | | **%** | % |
| Year of study | 3 | **Semester** | Spring | |
| ECTS credits | 4 | **Teaching Units** | 3 | |
| Name of lecturer | Dionissios Mantzavinos | | | |
| Learning outcomes | **CAT** | **Description** | | |
| | A | Ability to calculate diffusion coefficients in various systems | | |
| | C | Formulation of diffusion and convective mass transfer models | | |
| | D | Diffusion problems in various applications including unit operations such as evaporation, distillation, absorption | | |
| | E | Ability to design chemical processes involving mass transfer | | |
| Competences Prerequisites | The students are advised to refresh their knowledge in mass and energy balances, as well as in transport phenomena | | | |
| Module content | INTRODUCTION: Definition of concentrations, Velocities and special flux rates. Law of Fick. Phenomenological theory of molecular diffusion. Diffusion coefficient: gas, liquid and solid media. Differential equations of mass transfer (balances). Usual initial and boundary conditions.<br>Molecular diffusion: concentration distribution in solids and fluids resting. Steady state and transient molecular diffusion. Exact analytical solutions of standard problems, steady state and transient molecular diffusion.<br>DIFFUSION AND REACTION: Diffusion with homogeneous chemical reaction. Diffusion with heterogeneous reaction. Relative influence of the mass transfer rate and reaction.<br>Diffusion porous materials: Molecular diffusion in porous materials. Knudsen diffusion, Surface diffusion<br>DIFFUSION AND REACTION IN CATALYTIC GRAIN | | | |

| Module code | CHM_755 | | | |
|---|---|---|---|---|
| | SPECIAL TOPICS IN MASS TRANSFER: Theory of diffusion in gases at low pressure, Knudsen diffusion, diffusion in binary mixtures, diffusion in solid solids, diffusion in porous bodies and diffusion in multicomponent mixtures.<br>CONVECTIVE MASS TRANSFER: Dimensional analysis and similarity. Convection at low and high Reynolds and Peclet numbers. Mass transfer coefficient. Proportions of mass transfer and heat linear momentum. Proportions of Colburn and von Karman.<br>MASS TRANSFER AND POLLUTION IN WATER RESOURCES: STREETER-PHELPS EQUATIONS | | | |
| **Recommended literature** | 1. ΛΥΓΕΡΟΥ ΒΑΣΙΛΙΚΗ, ΑΣΗΜΑΚΟΠΟΥΛΟΣ ΔΙΟΝΥΣΗΣ, ΑΡΑΜΠΑΤΖΗΣ ΓΕΩΡΓΙΟΣ, "ΜΕΤΑΦΟΡΑ ΜΑΖΑΣ", Εκδόσεις Α.ΠΑΠΑΣΩΤΗΡΙΟΥ & ΣΙΑ ΟΕ, ΑΘΗΝΑ, 2005 | | | |
| | 2. Transport Phenomena: A Unified Approach, Brodkey & Hershey, McGraw-Hill | | | |
| **Teaching and learning methods** | **LECTURES** | **RECITATION** | **LAB/PRACTICE** | **PROJECT / HOMEWORK** |
| | 2 h/w | 1 h/w | 0 h/w | 0/semester |
| **Assessment type** | Written Examination | | | |
| **Assessment and grading methods** | There is a final examination accounting for 100% of the mark | | | |
| **Instruction Language** | Greek | | | |
| **Erasmus availability** | NO | | | |
| **Module URL** | https://eclass.upatras.gr/courses/CMNG2169/ | | | |
| **Last Amendment** | January 2017 | | | |

## Instrumental Chemical Analysis

| Module code | CHM_515 | | | |
|---|---|---|---|---|
| **Module title** | ***Instrumental Chemical Analysis*** | | | |
| **Status** | **Live** | **Type** | Compulsory | |
| **Category A** | Core Chemical Engineering | | **%** | 100% |
| **Category B** | Choose Module Category B | | **%** | % |
| **Year of study** | 3 | **Semester** | Spring | |
| **ECTS credits** | 4 | **Teaching Units** | 3 | |
| **Name of lecturers** | Dimitris Kondarides, Symeon Bebelis | | | |
| **Learning outcomes** | **CAT** | **Description** | | |
| | A | Basic knowledge of the instrumentation and applications of chromatography, spectroscopy and electroanalytical chemistry in chemical analysis. | | |
| | B | Familiarization with different types of analytical methods, analytical instrumentation and calibration methodology. | | |
| | B | Ability to choose and implement an instrumental method of analysis depending on the application and analysis needed. | | |
| **Competences Prerequisites** | General and Inorganic Chemistry (CHM_110), Analytical Chemistry (CHM_115) | | | |
| **Module content** | Extraction. Chromatographic methods of analysis. Theory of chromatography. Liquid chromatography, gel chromatography. Gas chromatography.<br>Spectroscopy in chemical analysis. Matter-radiation interaction. Quantitative analysis with absorption chromatography. Instrumentation. Infra-red spectrometry. UV-VIS spectroscopy. Flame photometry. Atomic absorption spectroscopy. X-ray spectrometry. | | | |

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

## Chemical Reaction Engineering I

| | | | | |
|---|---|---|---|---|
| **Module code** | **CHM_741** | | | |
| **Module title** | ***Chemical Reaction Engineering I*** | | | |
| **Status** | **Live** | **Type** | Compulsory | |
| **Category A** | Core Chemical Engineering | | **%** | 100% |
| **Category B** | Choose Module Category B | | **%** | % |
| **Year of study** | 3 | **Semester** | Spring | |
| **ECTS credits** | 4 | **Teaching Units** | 6 | |
| **Name of lecturer** | Alexandros Katsaounis | | | |
| **Learning outcomes** | **CAT** | **Description** | | |
| | A | Compute adiabatic temperatures and chemical equilibrium compositions. | | |
| | B | Understand the principles of chemical kinetics. | | |
| | C | Describe in detail the operation and design of the main types of ideal chemical reactors. | | |
| | D | Describe the main types of non-ideal chemical reactors. | | |
| **Competences Prerequisites** | General and Inorganic ChemistryIntroduction to Chemical Engineering (CHM_110), Analytical Chemistry Introduction to Chemical Engineering (CHM_140), Chemical Thermodynamics I & II (CHM_220, CHM_320) | | | |
| **Module content** | Adiabatic temperature, chemical equilibrium, fugacity, activity, chemical potential, principles of chemical kinetics, design equations of ideal chemical reactors, batch, CSTR, PFR. Non-ideal reactor models. | | | |
| **Recommended literature** | 1. C.G. Vayenas, "Analysis and Design of Chemical Reactors", Patras University Press (1986), in Greek | | | |
| | 2. H. Scott Fogler, "Elements of Chemical Reaction Engineering", Prentice-Hall International, Inc. (1986). | | | |

| **Module code** | **CHM_741** | | | |
|---|---|---|---|---|
| | 3. X.E. Verykios, “Chemical Reaction Kinetics and Design of Chemical Reactors”, University of Patras Press, Patras (1992), in Greek | | | |
| **Teaching and learning methods** | **LECTURES** | **RECITATION** | **LAB/PRACTICE** | **PROJECT / HOMEWORK** |
| | 3 h/w | 1 h/w | 0 h/w | 0/semester |
| **Assessment type** | Combined | | | |
| **Assessment and grading methods** | In class and take-home exercises (20%)<br>Progress exam (40%)<br>Final exam (40%) | | | |
| **Instruction Language** | Greek | | | |
| **Erasmus availability** | NO | | | |
| **Module URL** | http://www.chemeng.upatras.gr/en/content/courses/en/chemical-reaction-engineering-i | | | |
| **Last Amendment** | January 2017 | | | |

## Process Dynamics & Control

| **Module code** | **CHM_480** | | | |
|---|---|---|---|---|
| **Module title** | ***Process Dynamics & Control*** | | | |
| **Status** | Live | | **Type** | Compulsory |
| **Category A** | Core Chemical Engineering | | **%** | 70% |
| **Category B** | Chemical Engineering Practice | | **%** | 30% |
| **Year of study** | 3 | | **Semester** | Spring |
| **ECTS credits** | 7 | | **Teaching Units** | 5 |
| **Name of lecturers** | Michael Kornaros, Stavros Pavlou | | | |
| **Learning outcomes** | **CAT** | **Description** | | |
| | A | Have a good understanding of how to calculate and analyze dynamic behavior of physical systems, including fundamental notions of dynamics like stability and transfer function. | | |
| | B | Use and simplify block diagrams | | |
| | B | Construct and interpret Bode diagrams and root locus diagrams | | |
| | B | Understand the significance of controller actions (proportional, integral, derivative). | | |
| | A | Apply methods of optimal tuning of PID controllers | | |
| **Competences Prerequisites** | There are no prerequisite modules. Students should have some basic knowledge of differential equations and mass and energy balances | | | |
| **Module content** | DYNAMIC RESPONSE OF PHYSICAL SYSTEMS. First-order systems. Conn ections of first order systems. Second-order systems. Time delay systems.<br>MATHEMATICAL METHODS FOR THE ANALYSIS OF DYNAMIC SYSTEMS. Solution of linear vector differential equations with the exponential matrix method. Asymptotic stability of linear systems.Solution of linear differential equations using Laplace transforms. Transfer function. Poles and zeros. Input/output stability. Frequency response calculation. Bode diagrams. Linearization of nonlinear dynamic systems. Local asymptotic stability –Lyapunov’s first method<br>FEEDBACK CONTROL SYSTEMS. Measuring devices. Final Control Elements. Controllers with proportional, integral and/or derivative actions (PID). Block diagram representation of a control system. Block diagram simplification. Closed loop transfer functions. State-space description of a closed loop system. | | | |

| Module code | CHM_480 |
|---|---|
| | ANALYSIS AND DESIGN OF CONTROL SYSTEMS. Steady state error -significance of integral action. Sensitivity function. Closed loop stability analysis. Routh stability criterion. Bode stability criterion. Gain and phase margins. Root locus diagram. Calculation of performance criteria for control systems and optimization.<br>*Keywords -basic terms*: dynamic system; input; output; dynamic response; transfer function; stability; feedback; controller; block diagram; closed loop system. |
| **Recommended literature** | 1. N. Krikelis, "Introduction to Automatic Control", Athens technical University Editions |
| | 2. R. C. Dorf and R. H. Bishop, "Modern Control Systems", Prentice Hall |
| | 3. Νταουντίδης Π., Μαστρογεωργόπουλος Σ., Παπαδοπούλου Σ., "Έλεγχος Διεργασιών", Εκδ. Τζιόλα |

| | | | | |
|---|---|---|---|---|
| **Teaching and learning methods** | **LECTURES** | **RECITATION** | **LAB/PRACTICE** | **PROJECT / HOMEWORK** |
| | 3 h/w | 2 h/w | 1 h/w | 0/semester |
| **Assessment type** | Combined | | | |
| **Assessment and grading methods** | 1. Written lab reports (15% of the final mark).<br>2. Written examination (85% of the final mark) | | | |
| **Instruction Language** | Greek | | | |
| **Erasmus availability** | NO | | | |
| **Module URL** | https://eclass.upatras.gr/modules/auth/opencourses.php?fc=59 | | | |
| **Last Amendment** | December 2016 | | | |

## Polymers Laboratory

| | | | | |
|---|---|---|---|---|
| **Module code** | **CHM-671** | | | |
| **Module title** | ***Polymers Laboratory*** | | | |
| **Status** | Live | **Type** | Compulsory | |
| **Category A** | Chemical Engineering Practice | | **%** | 100% |
| **Category B** | Choose Module Category B | | **%** | % |
| **Year of study** | 3 | **Semester** | Spring | |
| **ECTS credits** | 3 | **Teaching Units** | 2 | |
| **Name of lecturer** | Constantinos Tsitsilianis | | | |

| | | |
|---|---|---|
| **Learning outcomes** | **CAT**[5] | **Description** |
| | B | Ability to organize and perform experiments using instrumental analytical techniques for the characterization of polymers and determination of their properties. |
| | B | Be acquainted with the basic knowledge of these techniques and process the data of the experiments. |
| | F | To evaluate the result and understand the polymers' properties from both laboratory experiments and "Polymer Science" module. |
| **Competences Prerequisites** | Students should have basic knowledge of Polymer Science and Instrumental Analysis. | |

| | | | | |
|---|---|---|---|---|
| **Module code** | **CHM-671** | | | |
| **Module content** | *Viscometry*: determination of intrinsic viscosity, average molecular weight Mv and molecular size of macromolecules by using Ubbelohde viscometers.<br>*Gel permeation chromatography (GPC):* determination of average molecular weights and molecular weight distribution of polymers.<br>*Infrared spectroscopy (FTIR):* application of FTIR for the identification of polymers and determination of copolymer composition.<br>*Ultra violet spectroscopy (UV):* application of UV spectroscopy for the study of polymer solubility. Determination of Θ temperature and the lower critical solution temperature (LCST).<br>*Differential scanning calorimetry (DSC):* determination of glass transition temperature, degree of crystallization and melting temperature of polymeric samples.<br>*Tensile Testing:* stress-strain curves of various polymeric samples and determination of mechanical ultimate properties.<br>*Polymer Rheology:* study of the rheological behavior of concentrated aqueous polymer solutions by using Couete viscometer, effect of Mw and temperature. | | | |
| **Recommended literature** | 1. "Εργαστήριο Πολυμερών" Σημειώσεις, Κ. Τσιτσιλιάνης, Ο. Κούλη Φεβρουάριος 2013 | | | |
| | 2. Experiments in Polymer Science, E.A. Collins, J. Bares, F.W. Billmeyer, Jr. Wiley, New York, 1973 | | | |
| **Teaching and learning methods** | **LECTURES** | **RECITATION** | **LAB/PRACTICE** | **PROJECT / HOMEWORK** |
| | 0 h/w | 0 h/w | 4 h/w | N/semester |
| **Assessment type** | Combined | | | |
| **Assessment and grading methods** | Multiple choise test, before practice (25%), Report with the results (25%), Final writing examination (50%). | | | |
| **Instruction Language** | Greek | | | |
| **Erasmus availability** | YES | | | |
| **Module URL** | https://eclass.upatras.gr/courses/CMNG2158/ | | | |
| **Last Amendment** | January 2017 | | | |

## 3.8 4th Year - 7th Semester

### Unit Operations I

| | | | | |
|---|---|---|---|---|
| **Module code** | **CHM_655** | | | |
| **Module title**[2] | ***Unit Operations I*** | | | |
| **Status** | Live | **Type** | Compulsory | |
| **Category A** | Core Chemical Engineering | | **%** | 70% |
| **Category B** | Chemical Engineering Practice | | **%** | 30% |
| **Year of study** | 4 | **Semester** | Fall | |
| **ECTS credits** | 6 | **Teaching Units** | 4 | |
| **Name of lecturer** | Christakis Paraskeva | | | |
| **Learning outcomes** | **CAT** | **Description** | | |
| | A | Students are trained in basic separation processes (Distillation, absorption, membranes, fixed and fluidized beds, etc) | | |
| | B | Students learn to apply theory, experimental methodology, data analysis and interpretation | | |

| Module code | CHM_655 | | | |
|---|---|---|---|---|
| | E | Students learn design unit operation processes with the aid of a process simulation software | | |
| | I | Students learn to work and co-operate in multidisciplinary teams to present their results in original reports | | |
| **Competences Prerequisites** | To attend the module the student is encouraged to refresh basic thermodynamics and physical chemistry knowledge especially for equilibrium vapor-liquid and liquid-liquid systems. We will also use knowledge from the module 'Mass and Energy Balances' | | | |
| **Module content** | Unit operation I includes the following modules:<br>Distillation - Distillation of binary mixtures: Equilibrium distillation, differential distillation, fractional distillation, Method McCabe-Thiele, Method Ponchon-Savarit, Performance Murphree., - Fractional distillation of multicomponent mixtures: Method wholesale analysis method accurate analysis.<br>Absorption: design equations and analysis, Absorption multistage countercurrent, Processes continuous contact Absorption complex mixtures.<br>Adsorption: Balance and isotherms (Langmuir, BET, etc.), dynamics and principles of adsorption curves crossing Design adsorption processes.<br>Evaporation, drying and extraction.<br>Fixed and Fluidized Beds: Conditions for fluidization. Gas-solid systems.<br>Membrane filtration (macrofiltration, Ultrafiltration, Nanofiltration, reverse osmosis): Separation mechanism, membrane materials, membrane configuration, synthesis, applications, etc<br>Process simulation software packages in Chemical Engineering.<br>Project for the complete design of a distilled column for the separation of a binary liquid mixture. | | | |
| **Recommended literature** | 1. ΙΩΑΝΝΗΣ ΓΕΝΤΕΚΑΚΗΣ, "ΦΥΣΙΚΕΣ ΔΙΕΡΓΑΣΙΕΣ'', ΕΚΔΟΣΕΙΣ ΚΛΕΙΔΑΡΙΘΜΟΣ Ε.Π.Ε., ΑΘΗΝΑ, 2010 | | | |
| | 2. McCABE WARREN, SMITH JULIAN C., HARRIOTT PETER "ΒΑΣΙΚΕΣ ΔΙΕΡΓΑΣΙΕΣ ΧΗΜΙΚΗΣ ΜΗΧΑΝΙΚΗΣ, ΕΚΔΟΣΕΙΣ Α.ΤΖΙΟΛΑ & ΥΙΟΙ Ο.Ε., ΘΕΣ/ΝΙΚΗ, 2002 | | | |
| | 3. ΑΣΣΑΕΛ ΜΑΡΚΟΣ Ι., ΜΑΓΓΙΛΙΩΤΟΥ ΜΑΡΙΑ Χ., "ΦΥΣΙΚΕΣ ΔΙΕΡΓΑΣΙΕΣ", ΕΚΔΟΣΕΙΣ Α.ΤΖΙΟΛΑ & ΥΙΟΙ Ο.Ε., ΘΕΣ/ΝΙΚΗ, 2009 | | | |
| **Teaching and learning methods** | **LECTURES** | **RECITATION** | **LAB/PRACTICE** | **PROJECT / HOMEWORK** |
| | 2 h/w | 2 h/w | 2 h/w | 2/semester |
| **Assessment type** | Combined | | | |
| **Assessment and grading methods** | (Final exam) x 0.7 + 0.1 x Project + (laboratory grade) x 0.2 = Final Grade | | | |
| **Instruction Language** | Greek | | | |
| **Erasmus availability** | YES | | | |
| **Module URL** | http://www.chemeng.upatras.gr/en/content/courses/en/unit-operations-i | | | |
| **Last Amendment** | December 2016 | | | |

## Biochemical Process Engineering

| Module code | CHM_742 | | | |
|---|---|---|---|---|
| **Module title** | ***Biochemical Process Engineering*** | | | |
| **Status** | Live | **Type** | Compulsory | |
| **Category A** | Core Chemical Engineering | | **%** | 100% |
| **Category B** | Choose Module Category B | | **%** | % |

| | | | | | |
|---|---|---|---|---|---|
| **Module code** | **CHM_742** | | | | |
| **Year of study** | 4 | | **Semester** | Fall | |
| **ECTS credits** | 6 | | **Teaching Units** | 5 | |
| **Name of lecturer** | Dionissios Mantzavinos | | | | |
| **Learning outcomes** | **CAT** | **Description** | | | |
| | A | Ability to apply principles of biology to derive energetics and stoichiometries in biological reactions | | | |
| | B | Data analysis and interpretation in enzymatic and biological reactions | | | |
| | C | Use and understanding of kinetic models in biochemical engineering | | | |
| | D | Understanding the role of biochemical enginnering in technological fields such as pharmaceuticals and waste treatment | | | |
| | E | Design of various types of bioreactors | | | |
| **Competences Prerequisites** | The students should refresh their knowledge in Microbiology | | | | |
| **Module content** | Basics of microbiology, biochemistry and genetics.<br>Biochemical reaction stoichiometry, mass balances and energetics of half reactions.<br>Enzyme kinetics. The Michaelis-Menten and Briggs-Haldane models. Determination of kinetic parameters. Factors affecting enzymatic reactions (multiple substrates, co-enzymes, pH, temperature, reversible reactions). Enzyme inhibition (competitive, non-competitive, uncompetitive) and deactivation. Immobilized enzymes (mass transfer limitations, Thiele modulus, effectiveness factor).<br>Kinetics of microbial growth, substrate utilization and metabolic product generation.<br>The Monod model and comparison of various kinetic models. Factors affecting microbial growth. Sterilization and disinfection.<br>Bioreactor types (batch, fed-batch, CSTR). Bioreactor design and productivity optimization.<br>Sequence of bioreactors. Biofilms (the ideal biofilm, biofilm models).<br>Bioseparations and down-stream processing (sedimentation, filtration, centrifugation, liquid-liquid extraction, chromatographic separations, electrophoresis, membranes, crystallization, drying). | | | | |
| **Recommended literature** | 1. Εισαγωγή στη Βιοχημική Μηχανική, Λυμπεράτου & Παύλου, Εκδόσεις Τζιόλα | | | | |
| | 2. Bioprocess Engineering, Shuler & Kargi, Prentice-Hall | | | | |
| | 3. Biochemical Engineering Fundamentals, Bailey & Ollis, 2nd edition, McGraw-Hill | | | | |
| **Teaching and learning methods** | **LECTURES** | **RECITATION** | **LAB/PRACTICE** | **PROJECT / HOMEWORK** | |
| | 3 h/w | 2 h/w | 0 h/w | 0/semester | |
| **Assessment type** | Written Examination | | | | |
| **Assessment and grading methods** | There is a final examination accounting for 100% of the mark | | | | |
| **Instruction Language** | Greek | | | | |
| **Erasmus availability** | YES | | | | |
| **Module URL** | https://eclass.upatras.gr/courses/CMNG2182/ | | | | |
| **Last Amendment** | January 2017 | | | | |

## Process and Plant Design

| | | | |
|---|---|---|---|
| **Module code** | **CHM_941** | | |
| **Module title** | ***Process and Plant Design*** | | |
| **Status** | Live | **Type** | Compulsory |

| | | | | | |
|---|---|---|---|---|---|
| **Module code** | **CHM_941** | | | | |
| **Category A** | Chemical Engineering Design Practice and Design Projects | | | **%** | 70% |
| **Category B** | Adv. Chem. Engineering (Design) | | | **%** | 30% |
| **Year of study** | 4 | | **Semester** | Fall | |
| **ECTS credits** | 6 | | **Teaching Units** | 5 | |
| **Name of lecturer** | Ioannis Kookos | | | | |
| **Learning outcomes** | **CAT** | **Description** | | | |
| | B | Ability to collect thermodynamic data and select appropriate thermodynamic models. | | | |
| | A | Ability to develop strategies for process systems simulation | | | |
| | C | Ability to use computer-based flowsheeting and numerical simulation tools to support process design activities | | | |
| | K | Ability to develop strategies for performing chemical process unit design. | | | |
| **Competences Prerequisites** | Material and Energy Balances, Thermodynamics, Transport Phenomena | | | | |
| **Module content[7]** | The following issues are addressed:<br>The difficulties encountered when simulating complex mixtures are analyzed and the basic elements of chemical engineering thermodynamics are reviewed. Thermodynamic models such as cubic EOS and activity models are critically reviewed. Ideal and non-ideal mixtures and solutions are reviewed and the corresponding thermodynamic models are presented. The estimation of thermo-physical properties using group contribution methods, such as the method Joback, are presented. The implementation of thermodynamic models into computer software and the use of pseudo-components are discussed.<br>The methods available for structuring process systems calculations, in order to take advantage of the sparse structure of the relevant equations, are analyzed and their implementation in the most commonly used commercial simulation tools is discussed. Recycle streams and their implications to the solution of the material and energy balances for complete plants are discussed. Examples of the efficient steady-state simulation of complete process flow diagrams are presented in the classroom.<br>The underlying principles for the design and sizing of main process units, such as distillation columns, heat exchangers, phase separation units, mixing tanks and reactors, pumps and compressors are analyzed in detail and the available methodologies are extended to non-conventional units. | | | | |
| **Recommended literature** | 1. I.K.KOOKOS, Analysis of Chemical Processes, Tziola Publishing, 2011, in Greek | | | | |
| | 2. I.K.KOOKOS, Chemical Process Design, Tziola Publishing, 2007, in Greek | | | | |
| | 3. Perry's Chemical Engineers Handbook, McGraw Hill, Available in electronic document in University Library | | | | |
| **Teaching and learning methods** | **LECTURES** | **RECITATION** | **LAB/PRACTICE** | **PROJECT / HOMEWORK** | |
| | 4h/w | 1 h/w | 0 h/w | 1/semester | |
| **Assessment type** | Combined | | | | |
| **Assessment and grading methods** | Final exam, weekly projects. | | | | |
| **Instruction Language** | Greek | | | | |
| **Erasmus availability** | NO | | | | |
| **Module URL** | https://eclass.upatras.gr/courses/CMNG2171/ | | | | |
| **Last Amendment** | December 2016 | | | | |

## Chemical Engineering Processes Laboratory I

| | | | | |
|---|---|---|---|---|
| **Module code** | **CHM_756** | | | |
| **Module title** | ***Chemical Engineering Processes Laboratory I*** | | | |
| **Status** | Live | **Type** | Compulsory | |
| **Category A** | Chemical Engineering Practice | | **%** | 100% |
| **Category B** | Choose Module Category B | | **%** | % |
| **Year of study** | 4 | **Semester** | Fall | |
| **ECTS credits** | 3 | **Teaching Units** | 2 | |
| **Name of lecturers** | Maria Dimarogona | | | |
| **Learning outcomes** | **CAT** | **Description** | | |
| | A | Students are trained in basic chemical engineering processes. | | |
| | B | Students learn to operate experimental laboratory or semi-pilot devices and present their results in original technical reports. | | |
| | D | Students exploit the knowledge gained in their respective theoretical modules. | | |
| **Competences Prerequisites** | There are no formal prerequisite modules. Basic knowledge by the following modules is necessary: Fluid Flow, Unit Operations, Mass Transfer, Chemical Process and Chemical Reactor Design, Mass and Energy Balances. | | | |
| **Module content**[7] | The Chemical Engineering Processes Laboratory I contains seven exercises, four refer Unit Operations (Instructor C. Paraskeva) and three to Chemical Processes (Instructor D. Spartinos). The exercises are performed by groups of 4-5 students:<br><br>The exercises of Unit Operations are:<br>***1. Gas Absorption***<br>Adsorption of CO2 in a packed bed absorption tower.<br>***2. Solid and fluidized bed***<br>Experimental estimation of porosity, permeability, mean grain diameter, specific area, friction coefficient, minimum and maximum (terminal) velocities in fluidized beds.<br>***3. Drag coefficient and viscosity***<br>Experimental estimation of drag force on a spherical particle and of the liquid viscosity.<br>***4. Diffusion of liquids and gases***<br>Experimental estimation of diffusion coefficient in gases (Arnold Cell) and in liquids. (Winkleman method).<br><br>The exercises of Chemical Processes are:<br>***1. Study of Chemical Reaction Kinetics in Gas Chromatography***<br>Kinetics of acetic methyl ester hydrolysis and quantitative and qualitative analysis of byproducts in gas chromatographer.<br>***2. Residence time distribution in a stirred reactor***<br>Experimental estimation of the residence time distribution function(E) and the percentage of the molecules with residence time less than time (t).<br>3. ***Catalytic Oxidation of Ethylene***<br>Catalytic oxidation of ethylene using catalysts as Pt, Pd, and Rh. | | | |
| **Recommended literature** | ΠΑΡΑΣΚΕΥΑ Χ. -ΣΠΑΡΤΙΝΟΣ Δ., "ΣΗΜΕΙΩΣΕΙΣ ΕΡΓΑΣΤΗΡΙΟΥ ΔΙΕΡΓΑΣΙΩΝ Ι", Εκδόσεις Πανεπιστημίου Πατρών, 2012, ΠΑΤΡΑ | | | |
| **Teaching and learning methods** | **LECTURES** | **RECITATION** | **LAB/PRACTICE** | **PROJECT / HOMEWORK** |
| | N h/w | N h/w | 4 h/w | 7/semester |
| **Assessment type** | Combined | | | |
| **Assessment and grading methods** | The evaluation of the exercises of Unit Operations is as follows:<br>1. Written examination, after running all 4 exercises (theory and simple exercises) (50%), | | | |

| | |
|---|---|
| | 2. Marking of the final report (50%).<br>The evaluation of Chemical Processes exercises is as follows:<br>1. Written examination at the end of each exercise (50%).<br>2. Marking of the final report (50%).<br>In the end, the average of the seven exercises is summed and averaged out the module. |
| **Instruction Language** | Greek |
| **Erasmus availability** | NO |
| **Module URL** | http://www.chemeng.upatras.gr/en/content/courses/en/chemical-engineering-processes-laboratory-i |
| **Last Amendment** | December 2016 |

## Chemical Reaction Engineering II

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

| **Learning outcomes** | **CAT** | **Description** |
|---|---|---|
| | D | A good understanding of the basic principles and applications of heterogeneous catalysis and of the structure of solid catalysts. |
| | D | A good understanding of the concept of the intrinsic rate of catalytic reactions and of the concept of the global (overall) rate. |
| | A | Ability to develop the intrinsic rate of catalytic reactions through their mechanism and to test it with experimental data. |
| | A | Ability to incorporate phenomena of external and/or internal mass and heat transfer to the intrinsic rate and develop the global rate of catalytic reactions. |
| | C | Familiarization with the different models of simulation of catalytic reactors and their basic assumptions |

| | |
|---|---|
| **Competences Prerequisites** | Chemical Reaction Engineering I |
| **Module content** | 1. Qualitative description of various types of heterogeneous reactors.<br>2. The catalytic action, catalytic reactions, preparation and characterization of catalysts.<br>3. Mechanisms of catalytic reactions and development of the intrinsic rate.<br>4. Mass and heat transport phenomena in various reactor types.<br>5. Internal mass and heat transport phenomena. Effectiveness factor.<br>6. Catalytic reactor models and basic principleas of their simulation. |
| **Recommended literature** | 1. X. E. Verykios, " Heterogeneous Catalytic Reactions and Reactors", Kostarakis Publications, Athens 2004 (in Greek) |
| | 2. M. Smith, "Chemical Engineering Kinetics", McGraw-Hill, New York 1981. |

| **Teaching and learning methods** | **LECTURES** | **RECITATION** | **LAB/PRACTICE** | **PROJECT / HOMEWORK** |
|---|---|---|---|---|
| | 3 h/w | 2 h/w | 0 h/w | 0/semester |
| **Assessment type** | Combined | | | |

| Module code | CHM_841 |
|---|---|
| Assessment and grading methods | Problem solving through the entire semester (mandatory)<br>One or two quizzes during the term.<br>Final written exam at the end of the term |
| Instruction Language | Greek |
| Erasmus availability | NO |
| Module URL | https://eclass.upatras.gr/courses/CMNG2186/ |
| Last Amendment | January 2017 |

## Production and Project Management

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

## Introduction to Business Administration

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

## General Ecology

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

## Operational Research

| **Module code** | **CHM_799** | | |
|---|---|---|---|
| **Module title** | ***Operational Research*** | | |
| **Status** | Live | **Type** | Elective |

| | | | | |
|---|---|---|---|---|
| **Module code** | **CHM_799** | | | |
| **Category A** | Management & Economics | | **%** | 100% |
| **Year of study** | 4 | **Semester** | Fall | |
| **ECTS credits** | 3 | **Teaching Units** | 3 | |
| **Name of lecturer(s)** | Department of Business Administration | | | |

Introduction to Economics for Engineers and Scientists

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

Introduction to Business Administration for Engineers and Scientists

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

## 3.9 4th Year – 8th Semester

Plant Design and Economics Laboratory

| | | | | |
|---|---|---|---|---|
| **Module code** | **CHM_1041** | | | |
| **Module title** | ***Plant Design Laboratory*** | | | |
| **Status** | Live | **Type** | Compulsory | |
| **Category A** | Chemical Engineering Design Practice and Design Projects | | **%** | 60% |
| **Category B** | Adv. Chem. Engineering (Design) | | **%** | 40% |
| **Year of study** | 4 | **Semester** | Spring | |
| **ECTS credits** | 10 | **Teaching Units** | 6 | |
| **Name of lecturers** | Ioannis Kookos, Dimitris Vayenas | | | |
| **Learning outcomes** | **CAT** | **Description** | | |
| | A | Ability to search the literature in order to propose different design options and use of qualitative and quantitative assessment criteria for their evaluation | | |
| | A | Ability to understand and resolve conflicting performance criteria | | |
| | G | Ability to study and apply detailed design procedures for key process units | | |

| Module code | CHM_1041 | |
|---|---|---|
| | H | Ability to use preliminary HAZOP analysis to identify safety procedures |
| | I | Ability to demonstrate proficiency in modelling and simulation of process plants using commercial software |
| | J | Ability to prepare and present technical reports |
| | K | Ability to. manage a large scale project and working relationships within a large team effectively |

| | |
|---|---|
| **Competences Prerequisites** | Plant Design, Thermodynamics, Separtion Processes, ReactionEngineering |
| **Module content** | Students work in groups of 4-6 students. Each group is asked to develop a complete design that includes:<br>• **Process technology selection**<br>The students collect information relative to alternative process technologies for producing the targeted product and use qualitative and quantitative criteria in order to propose a preliminary process flow diagram (PFD).<br>• **Process simulation and energy and process integration**<br>The PFD is simulated in a commercial simulator in order to construct detailed material and energy balances. The simulation is then followed by heat and process integration with the aim to simplify the PFD and to minimize energy consumption.<br>• **Detailed design of Key Process Units**<br>Key process units are identified based on economic, safety and environmental performance criteria and groups are expected to develop detailed design for these units. Some of these units are new to the students (self-learning).<br>• **HAZOP analysis**<br>Having established a preliminary PFD the groups are expected to identify key process units for safety review. The groups are performing HAZOP analysis with the aim to propose appropriate hazard and risk management procedures.<br>• **Techno-economic analysis and technical report preparation**<br>Using the final PDF a detailed techno-economic evaluation is performed and a technical report is prepared and defended orally to a panel of academics. The potential Environmental Impact of the process in evaluated and an Life Cycle Inventory (LCI) is included in the report. |
| **Recommended literature** | 1. I.K.KOOKOS, Analysis of Chemical Processes, Tziola Publishing, 2011, in Greek |
| | 2. I.K.KOOKOS, Chemical Process Design, Tziola Publishing, 2007, in Greek |
| | 3. Perry's Chemical Engineers Handbook, McGraw Hill, Available in electronic document in University Library |

| **Teaching and learning methods** | **LECTURES** | **RECITATION** | **LAB/PRACTICE** | **PROJECT / HOMEWORK** |
|---|---|---|---|---|
| | 4 h/w | 0 h/w | 6 h/w | 1/semester |

| | |
|---|---|
| **Assessment type** | Combined |
| **Assessment and grading methods** | Weekly Team and Individual student assessment, oral presentation, technical report. |
| **Instruction Language** | Greek |
| **Erasmus availability** | NO |
| **Module URL** | https://eclass.upatras.gr/courses/CMNG2166/ |
| **Last Amendment** | December 2016 |

## Chemical Engineering Processes Laboratory II

| **Module code** | **CHM_846** |
|---|---|
| **Module title** | ***Chemical Engineering Processes Laboratory II*** |

<table>
<tr><td>Module code</td><td colspan="5">CHM_846</td></tr>
<tr><td>Status</td><td colspan="2">Live</td><td>Type</td><td colspan="2">Compulsory</td></tr>
<tr><td>Category A</td><td colspan="3">Chemical Engineering Practice</td><td>%</td><td>100%</td></tr>
<tr><td>Category B</td><td colspan="3">Choose Module Category B</td><td>%</td><td>%</td></tr>
<tr><td>Year of study</td><td colspan="2">4</td><td>Semester</td><td colspan="2">Spring</td></tr>
<tr><td>ECTS credits</td><td colspan="2">3</td><td>Teaching Units</td><td colspan="2">2</td></tr>
<tr><td>Name of lecturerσ</td><td colspan="5">Maria Dimarogona</td></tr>
<tr><td rowspan="5">Learning outcomes</td><td>CAT</td><td colspan="4">Description</td></tr>
<tr><td>A</td><td colspan="4">Students are trained in basic chemical and biochemical engineering processes.</td></tr>
<tr><td>B</td><td colspan="4">Students learn to operate experimental laboratory or semi-pilot devices and present their results in original technical reports.</td></tr>
<tr><td>D</td><td colspan="4">Students exploit the knowledge gained in their respective theoretical modules.</td></tr>
<tr><td>I</td><td colspan="4">Students learn to work and co-operate in multidisciplinary teams to present their results in original technical reports</td></tr>
<tr><td>Competences Prerequisites</td><td colspan="5">There are no formal prerequisite modules. Basic knowledge by the following modules is necessary: Fluid Flow, Heat Transfer, Unit Operations, and Biochemical Process Engineering</td></tr>
<tr><td>Module content</td><td colspan="5">Laboratory exercises based on Unit Operations:<br>1. Flow in a network of pipelines<br>Calculation of pressure drop values in a network of tubes, calculation of flowrates and fiction losses based on the Poiseuille equation<br>2. Heat exchanger<br>Energy balances, conduct surfaces, overall heat coefficient, etc<br>The students learn to design complicated systems of flow in networks of pipelines (pressures, flowrates, geometrical characteristics, friction losses) and to design heat exchangers for the heating or cooling of liquid streams<br><br>Laboratory exercises based on Biochemical Processes:<br>3. Measurement of chemical oxygen demand (COD)<br>Estimation of the organic load in a sample of wastewater. The method is based on complete catalytic chemical oxidation of the organic compounds contained in a wastewater sample.<br>4. Measurement of biochemical oxygen demand (BOD)<br>Estimation of the organic content that can be degraded biologically (by microorganisms) in a sample of wastewater<br>5. Microbial growth<br>Growth stages of a microbial culture and procedure to be followed for the estimation of kinetic parameters of growth<br>The students learn the concept of Chemical Oxygen Demand and Biochemical Oxygen Demand as measurements of the organic content of a wastewater sample and have a greater understanding of the microbial growth rates</td></tr>
<tr><td rowspan="3">Recommended literature</td><td colspan="5">1. ΠΑΡΑΣΚΕΥΑ Χ. - ΚΟΡΝΑΡΟΣ Μ. "ΣΗΜΕΙΩΣΕΙΣ ΕΡΓΑΣΤΗΡΙΟΥ ΔΙΕΡΓΑΣΙΩΝ ΙΙ", Εκδόσεις Πανεπιστημίου Πατρών, 2012, ΠΑΤΡΑ</td></tr>
<tr><td colspan="5">2. "Μηχανική Υγρών Αποβλήτων. Επεξεργασία και Επαναχρησιμοποίηση - Τόμος Α" 4η Έκδοση, Metcalf & Eddy, Εκδ. Τζιόλα, 2006, Θεσ/νίκη. ISBN: 960-148-109-2</td></tr>
<tr><td colspan="5">3. "Διαχείριση Υγρών Αποβλήτων", Γ. Λυμπεράτος και Δ. Βαγενάς, Εκδ. Τζιόλα, 2011, Θεσ/νίκη. ISBN: 978-960-418-346-3</td></tr>
<tr><td rowspan="2">Teaching and learning methods</td><td colspan="2">LECTURES</td><td>RECITATION</td><td>LAB/PRACTICE</td><td>PROJECT / HOMEWORK</td></tr>
<tr><td colspan="2">0 h/w</td><td>0 h/w</td><td>4 h/w</td><td>5/semester</td></tr>
<tr><td>Assessment type</td><td colspan="5">Combined</td></tr>
</table>

| | |
|---|---|
| **Module code** | **CHM_846** |
| **Assessment and grading methods** | The evaluation of the exercises of Unit Operations is as follows:<br>The evaluation of Unit Operatiosn is as follows:<br>1. Written examination, after running the 2 exercises (theory and simple exercises) (50%),<br>2. Marking of the final report (50%).<br><br>The evaluation of Biochemical Processes exercises is as follows:<br>1. Assessment of each student's performance during each exercise implementation and oral examination (50% of the final mark)<br>2. Written examination (50% of the final mark)<br>In the end, the average of the five exercises summed and averaged out the module. |
| **Instruction Language** | Greek |
| **Erasmus availability** | NO |
| **Module URL** | http://www.chemeng.upatras.gr/en/content/courses/en/chemical-eng-processes-laboratory-ii |
| **Last Amendment** | December 2016 |

## Unit Operations II

| | | | | |
|---|---|---|---|---|
| **Module code** | **CHM_855** | | | |
| **Module title** | ***Unit Operations II*** | | | |
| **Status** | Live | **Type** | Compulsory | |
| **Category A** | Core Chemical Engineering | | **%** | 70% |
| **Category B** | Chemical Engineering Practice | | **%** | 30% |
| **Year of study** | 4 | **Semester** | Fall | |
| **ECTS credits** | 6 | **Teaching Units** | 4. | |
| **Name of lecturer** | Christakis Paraskeva | | | |
| **Learning outcomes** | **CAT** | **Description** | | |
| | A | Students are trained in basic Unit Operations (Network of tubes, pumps, heat exchangers) | | |
| | B | Students learn to work with computing methodology and a commercial software to design unit operation processes s learn design unit operation processes | | |
| | E | Students learn to design heat exchangers and calculate friction losses in network of tubes | | |
| | I | Students learn to work and co-operate in multidisciplinary teams to present their results in original reports | | |
| **Competences Prerequisites** | To attend the module the student is encouraged to refresh basic Fluid Mecanics and Heat Transfer conecpts. | | | |
| **Module content** | Introduction, definitions and principles. Dimensional analysis. Fluid statics and applications. Fluid flow phenomena. Basic fluid flow equations: Mass balance, Differential and macroscopic momentum balances, Mechanical energy equation. Bernoulli equation corrections. Incompressible flow in pipes and channels. Shear stress and skin friction, friction coefficient. Laminar flow of Newtonian fluids. Velocity distribution in turbulent flow. Friction from changes in velocity or direction. Minor losses. Pipes fittings and pumps. Developed head. Suction lift and cavitation. Power consumption, pump characteristics. Heat transfer by conduction. Principles of heat flow in fluids. Typical heat exchange equipment. Energy Balances. Heat flux and heat transfer coefficients. Mean fluid temperature. Overall heat transfer coefficient, Logarithmic Mean Temperature Difference. Individual heat | | | |

| Module code | CHM_855 | | | |
|---|---|---|---|---|
| | transfer coefficients and calculation of the overall heat transfer coefficient. Fouling factors. Heat transfer to fluids without phase change: forced convection in laminar and turbulent flow. Heat transfer equipment. Single pass and multi pass cell and tube heat exchangers. | | | |
| Recommended literature | 1. Unit Operations of Chemical Engineering (7th edition). W. L. McCabe, J. C. Smith, P. Harriott. McGraw-Hill ISBN 007-124710-6 | | | |
| | 2. McCABE WARREN, SMITH JULIAN C., HARRIOTT PETER "ΒΑΣΙΚΕΣ ΔΙΕΡΓΑΣΙΕΣ ΧΗΜΙΚΗΣ ΜΗΧΑΝΙΚΗΣ, ΕΚΔΟΣΕΙΣ Α.ΤΖΙΟΛΑ & ΥΙΟΙ Ο.Ε., ΘΕΣ/ΝΙΚΗ, 2002 | | | |
| | 3. Σημειώσεις Φυσικών Διεργασιών ΙΙ, Α.Χ. Παγιατάκης, Εκδόσεις Πανεπιστημίου Πατρών | | | |
| Teaching and learning methods | **LECTURES** | **RECITATION** | **LAB/PRACTICE** | **PROJECT / HOMEWORK** |
| | 2 h/w | 2 h/w | 2 h/w | 2/semester |
| Assessment type | Combined | | | |
| Assessment and grading methods | (Final exam) x 0.7 + 0.1 x Project + (laboratory grade) x 0.2 = Final Grade | | | |
| Instruction Language | Greek | | | |
| Erasmus availability | YES | | | |
| Module URL | http://www.chemeng.upatras.gr/en/content/courses/en/unit-operations-ii | | | |
| Last Amendment | December 2016 | | | |

## Industrial Chemical Technologies

| Module code | CHM_835 | | | |
|---|---|---|---|---|
| Module title | ***Industrial Chemical Technologies*** | | | |
| Status | Live | **Type** | Compulsory | |
| Category A | Core Chemical Engineering | | **%** | 70% |
| Category B | Chemical Engineering Practice | | **%** | 30% |
| Year of study | 4 | **Semester** | Spring | |
| ECTS credits | 5 | **Teaching Units** | 4 | |
| Name of lecturer(s) | Dimitrios Spartinos | | | |
| Learning outcomes | **CAT** | **Description** | | |
| | A | The understanding of Inorganic and Organic Chemical Technologies. | | |
| | D | Study of flow sheets. | | |
| | F | The combination of theoretical knowledge with practice. | | |
| | K | The students realize projects on Chemical Technologies after visiting Chemical Industries. | | |
| Competences Prerequisites | There are no formal prerequisite modules. Basic knowledge by the following modules is necessary: Mass and Energy Balances, Unit Operations, Chemical Reaction Engineering. | | | |
| Module content | 1. Energy and raw materials in Chemical Industry<br>The basic processes of Chemical Industry<br>Water in Chemical Industry<br>2. Production of $O_2$, $N_2$ and $H_2$ - Reforming of $CH_4$<br>Electrolytic decomposition of $H_2O$<br>Reforming of $CH_4$<br>3. Production of $NH_3$ and $HNO_3$<br>Production of dilute $HNO_3$ in low and high pressure units<br>Production of concentrated $HNO_3$ | | | |

| Module code | CHM_835 | | | |
|---|---|---|---|---|
| | 4. Production of $SO_2$ and $H_2SO4$<br>Production of $SO_2$<br>Oxidation of $SO_2$<br>$H_2SO_4$ production unit<br>5. Fertilizers industry<br>Phosphoric fertilizers<br>Nitrogen fertilizers<br>Potassium fertilizers<br>Complex and Mixed fertilizers<br>6. Cement industry<br>Portland cement<br>Hydration of Portland cement<br>Pozolanic cement<br>7. Oils and fats industry<br>Production processes of seed-oils<br>Refinment and hydrogenation of oils<br>Butter, olive oil<br>8. Soap and detergents industry<br>Soaps, Glycering, Detergents<br>9. Food and beverages industry<br>Categories of food processes<br>Alcoholic fermentation<br>Production industries of wine, beer and alcoholic drinks<br>$CH_3CH_2OH$ production industries<br>10.Paper industry<br>Wood products<br>Pulp production<br>Paper production | | | |
| **Recommended literature** | 1. Α. Θ. Σδούκου, Φ.Ι. Πομώνη, Ανόργανη Χημική Τεχνολογία, Εκδ. Τζιόλα (2010). | | | |
| | 2. Ν. Κλούρα, Βασική Ανόργανη Χημεία, Εκδ. Τραυλός (2002). | | | |
| | 3. Δ. Σπαρτινού, Οργανική Χημική Τεχνολογία, Εκδ. Πανεπιστημίου Πατρών (2012). | | | |
| **Teaching and learning methods** | **LECTURES** | **RECITATION** | **LAB/PRACTICE** | **PROJECT / HOMEWORK** |
| | 2 h/w | 2 h/w | 4 h/w | 1 team project/semester |
| **Assessment type** | Combined | | | |
| **Assessment and grading methods** | 1. Written examination (50%).<br>2. Team projects about industries, following visits by groups of students to chemical industries (50%).<br>a) Written report (30%).<br>b) Oral presentation (20%). Audience including industry specialists. | | | |
| **Instruction Language** | Greek | | | |
| **Erasmus availability** | YES | | | |
| **Module URL** | http://eclass.upatras.gr/courses/CMNG2109 | | | |
| **Last Amendment** | December 2016 | | | |

## Process Health and Safety

| Module code | CHM_884 | | |
|---|---|---|---|
| **Module title** | ***Process Health and Safety*** | | |
| **Status** | Live | **Type** | Compulsory or Elective |

| **Module code** | **CHM_884** | | | | |
|---|---|---|---|---|---|
| **Category A** | Chemical Engineering Practice | | | **%** | 70% |
| **Category B** | Adv. Chem. Engineering (Practice) | | | **%** | 30% |
| **Year of study** | 4 | | **Semester** | Spring | |
| **ECTS credits** | 3 | | **Teaching Units** | 3 | |
| **Name of lecturer** | Dimitris Vayenas | | | | |
| **Learning outcomes** | **CAT[5]** | **Description** | | | |
| | A | Ability to use basic knowledge to avoid risk | | | |
| | B | Ability to apply experimental and computing methodology, data analysis and interpretation to predict risk and avoid leakages, explosions etc. | | | |
| | D | Knowledge of chemical engineering principles and their technological applications | | | |
| | E | Ability to design and assess safe chemical processes including the use of process simulation software | | | |
| | G | Ability to function professionally and behave ethically, taking into account social, environmental and health and safety issues | | | |
| | I | Ability to cooperate with multidisciplinary teams | | | |
| | K | Ability to prepare and present projects | | | |
| **Competences Prerequisites** | | | | | |
| **Module content** | Meaning of risk- hazardousness<br>Risk identification methods<br>Frequency of potential risks occurrence<br>Human factor<br>Pressurized gas leakage<br>Liquid leakage<br>Two-phase vapor-liquid mist<br>Fires<br>Explosions gas cloud<br>Bleve Explosions<br>Toxic cloud dispersion<br>Causes of equipment destruction<br>Ignition | | | | |
| **Recommended literature** | 1. M.I. Ασσαέλ, Κ.Ε. Κακοσίμος, Ανάλυση Επικινδυνότητας, Εκδ. Τζιόλα, 2008. ISBN: 976-960-418-148-3 | | | | |
| | 2. R.E. Sanders, Chemical process safety, Elsevier, eBook ISBN: 075067749X | | | | |
| **Teaching and learning methods** | **LECTURES** | **RECITATION** | **LAB/PRACTICE** | **PROJECT / HOMEWORK** | |
| | 3 h/w | 0 h/w | 0 h/w | 1/semester | |
| **Assessment type** | Combined | | | | |
| **Assessment and grading methods** | Written examination counts for 60% while the project counts for 40% of the final grade | | | | |
| **Instruction Language** | Greek | | | | |
| **Erasmus availability** | YES | | | | |
| **Module URL** | https://eclass.upatras.gr/courses/CMNG2202/ | | | | |
| **Last Amendment** | January 2017 | | | | |

## Management Information Systems I

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

## Operations Strategy I

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

## Technology – Innovation -Entrepreneurship

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

## Operations Research I

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

## Technical Project Management

| | | | |
|---|---|---|---|
| **Module code** | **CHM_797** | | |
| **Module title** | ***Technical Project Management*** | | |
| **Status** | Live | **Type** | Elective |

| | | | | |
|---|---|---|---|---|
| **Module code** | **CHM_797** | | | |
| **Category A** | Management & Economics | | **%** | 100% |
| **Year of study** | 1 | **Semester** | Spring | |
| **ECTS credits** | 3 | **Teaching Units** | 3 | |
| **Name of lecturer(s)** | Department of Mechanical Engineering & Aeronautics | | | |

## Organisms, Populations & Environment

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

## Practical Training in Industry & Enterprises (Job Internship)

| | | | | |
|---|---|---|---|---|
| **Module code** | **CHM_898** | | | |
| **Module title** | ***Practical Training in Industry & Enterprises*** | | | |
| **Status** | Live | **Type** | Elective | |
| **Category A** | Chemical Engineering Practice | | **%** | 100% |
| **Category B** | Choose Module Category B | | **%** | % |
| **Year of study** | 4 | **Semester** | Spring | |
| **ECTS credits** | 3 | **Teaching Units** | 3 | |
| **Name of lecturer** | George Angelopoulos | | | |
| **Learning outcomes** | **CAT** | **Description** | | |
| | A | Gain work experience and develop skills | | |
| | G | Experience a prospective career path | | |
| | B | Gain practical experience, by applying methods and theories learned in classes | | |
| | K | Network with professionals of the field, for references and future job opportunities | | |
| **Competences Prerequisites** | Prior Knowledge/Skills required NONE<br>pre-requisites normally required (desired) NONE | | | |
| **Module content** | The continuous and rapid scientific and technological developments in the field of Chemical Engineering create increased demands for full and comprehensive training of students. Summer internships provide students with valuable work as well as networking experience. In the Chemical Engineering Department, practical training (job internship) is active from the mid-1980s. In 1993 became an elective course.<br>Internships can be important assets to students' overall educational experience as often help them to confirm their career interests and build their resume. Moreover in some cases, can lead to full-time employment. Internships provide a hands-on opportunity in a professional setting and help students to develop soft skills and/or improve their technical skill within a practical and professional environment. Additionally, students develop | | | |

| Module code | CHM_898 | | | |
|---|---|---|---|---|
| | important for their professional career real-world skills such as knowing how to make a good impression, communicate with others and be an organized and respected employee. Likewise, undergraduate students pursuing research opportunities enrich their academic experience and build a competitive edge in the job market.<br>Within this frame, students can get an internship in companies, industries or organizations of public or private-sector or research institutions with activities related to the subject of chemical engineering. The duration of the internship can be minimum one (1), one and a half (1.5) or maximum two (2) months and depends on the agreement with the institution. Internship are available during sophomore and senior years although is a course of the 8th semester.<br>The internship coordinator of the Department, with another two faculty members and a person from the administration:<br>• Assist students with their internship preparation and finding an internship.<br>• Work with the students to improve their interviewing techniques, sharpen their résumé writing skills, and direct them to the internship opportunities that match their interests and professional goals.<br>Students can locate an internship by their own or to take advantage of the existing data base of collaborating companies (more than 250) which is updated every year. Furthermore they can get support from the specifically dedicated Office “Job Practice” of the University which assists students with locating internship and research opportunities. Students may also conduct an internship in another country in the frame of the Erasmus+ Programme | | | |
| **Recommended[8] literature** | 1. NONE | | | |
| | 2. NONE | | | |
| | 3. NONE | | | |
| **Teaching and learning methods** | **LECTURES** | **SEMINARS** | **LAB/PRACTICE** | **PROJECT / HOMEWORK** |
| | Not applicable | Not applicable | Not applicable | Not applicable |
| **Assessment type[9]** | Combined | | | |
| **Assessment and grading methods** | Oral presentation of the work performed. Gained experience and main results. Evaluation of the submitted work report. Consideration of the employer’s evaluation report | | | |
| **Instruction Language** | Greek | | | |
| **Erasmus availability** | NO | | | |
| **Course URL** | https://eclass.upatras.gr/courses/CMNG2152/ | | | |
| **Last Amendment** | February 2017 | | | |

## 3.10 5th Year – 9th Semester

### Wastewater Engineering

| **Module code** | **CHM_E_A1** | | | |
|---|---|---|---|---|
| **Module title** | ***Wastewater Engineering*** | | | |
| **Status** | Live | **Type** | Elective | |
| **Category A** | Adv. Chem. Engineering (Depth) | | **%** | 50% |
| **Category B** | Adv. Chem. Engineering (Breadth) | | **%** | 50% |
| **Year of study** | 5 | **Semester** | Fall | |
| **ECTS credits** | 4 | **Teaching Units** | 3 | |
| **Name of lecturers** | Michael Kornaros, Dionissions Mantzavinos | | | |

<table>
<tr><td>Module code</td><td colspan="4">CHM_E_A1</td></tr>
<tr><td rowspan="5">Learning outcomes</td><td>CAT</td><td colspan="3">Description</td></tr>
<tr><td>A</td><td colspan="3">Ability to apply biochemical engineering principles to wastewater treatment processes</td></tr>
<tr><td>C</td><td colspan="3">Ability to formulate mathematical models able to describe physicochemical and/or biological processes pertaining to either municipal or industrial wastewater treatment</td></tr>
<tr><td>D</td><td colspan="3">Knowledge of physicochemical (conventional/advanced oxidation) and biological processes and their application in wastewater treatment plants</td></tr>
<tr><td>E</td><td colspan="3">Ability to design and assess both chemical (including advanced oxidation) as well as biological processes for municipal and industrial wastewater treatment systems</td></tr>
<tr><td>Competences Prerequisites</td><td colspan="4">There are no prerequisites for this module. However, students should have basic knowledge of mass and energy balances, unit operations and biochemical processes.</td></tr>
<tr><td>Module content</td><td colspan="4">Wastewater flowrates. Qualitative and quantitative characteristics of wastewaters. Sewage networks. Legislation and treatment levels. Pretreatment (screens, grit chambers, grease removal, flow stabilization). Primary sedimentation and flotation. Fundamentals of microbiology and microbial kinetics. Secondary treatment. The activated sludge process. Alternative secondary suspended growth systems. Biofilm systems (trickling filters and biodiscs). Nutrient removal (nitrification, denitrification, biological phosphorus removal). Modelling of activated sludge systems. Natural systems for wastewater treatment. Disinfection. Sludge (biosolids) management.<br><br>Sources and characteristics of industrial effluents. Methods of evaluation of the polluting loading. Physical and chemical treatment technologies:<br>• Coagulation - flocculation<br>• Chemical precipitation<br>• Adsorption<br>• Membranes<br>Advanced oxidation processes (AOPs)<br>• Ozone oxidation<br>• Photocatalysis<br>• Electrochemical processes<br>• Ultrasound irradiation<br>• Thermochemical processes<br>Process integration<br>Effluent valorization and recovery of valuable products</td></tr>
<tr><td rowspan="3">Recommended literature</td><td colspan="4">1. "Μηχανική Υγρών Αποβλήτων. Επεξεργασία και Επαναχρησιμοποίηση - Τόμος Α" 4η Έκδοση, Metcalf & Eddy, Εκδ. Τζιόλα, 2006, Θεσ/νίκη. ISBN: 960-148-109-2</td></tr>
<tr><td colspan="4">2. "Διαχείριση Υγρών Αποβλήτων", Γ. Λυμπεράτος και Δ. Βαγενάς, Εκδ. Τζιόλα, 2011, Θεσ/νίκη. ISBN: 978-960-418-346-3</td></tr>
<tr><td colspan="4">3. Advanced Oxidation Processes for Water & Wastewater Treatment, Ed. S.A. Parsons, IWA Publishing, 2004</td></tr>
<tr><td rowspan="2">Teaching and learning methods</td><td>LECTURES</td><td>RECITATION</td><td>LAB/PRACTICE</td><td>PROJECT / HOMEWORK</td></tr>
<tr><td>3 h/w</td><td>0 h/w</td><td>0 h/w</td><td>1/semester</td></tr>
<tr><td>Assessment type</td><td colspan="4">Combined</td></tr>
<tr><td>Assessment and grading methods</td><td colspan="4">The assessment of each student's performance is as follows:<br>50% written examination<br>50% project</td></tr>
<tr><td>Instruction Language</td><td colspan="4">Greek</td></tr>
<tr><td>Erasmus availability</td><td colspan="4">YES</td></tr>
</table>

| | |
|---|---|
| **Module code** | **CHM_E_A1** |
| **Module URL** | https://eclass.upatras.gr/courses/CMNG2143/ |
| **Last Amendment** | December 2016 |

## Process Optimization and Control

| | | | | | |
|---|---|---|---|---|---|
| **Module code** | **CHM_E_A2** | | | | |
| **Module title** | ***Process Optimization and Control*** | | | | |
| **Status** | Live | | **Type** | Elective | |
| **Category A** | Adv. Chem. Engineering (Depth) | | | **%** | 100% |
| **Category B** | Choose Module Category B | | | **%** | % |
| **Year of study** | 5 | | **Semester** | Fall | |
| **ECTS credits** | 4 | | **Teaching Units** | 3 | |
| **Name of lecturer** | Ioannis Kookos | | | | |
| **Learning outcomes** | **CAT** | **Description** | | | |
| | B | Ability to develop mathematical programming formulations for classical engineering design problems, | | | |
| | A | Ability to use computer software (MATLAB, GAMS) to solve process optimization problems | | | |
| | D | Ability to evaluate critically the solutions obtained using numerical software | | | |
| **Competences Prerequisites** | None | | | | |
| **Module content** | Basic principles and definitions.<br>Necessary conditions for optimality.<br>General structure of optimization algorithms.<br>Optimization without constraints.<br>Linear and non-linear programming.<br>Integer programming.<br>Applications to the design of chemical/biochemical plants.<br>Tuning of classical, fixed structure controllers, using classical optimization methodologies.<br>Optimal Control problems and their numerical solution. | | | | |
| **Recommended literature** | 1. I. Kookos & A. Koutinas, Process and Systems Optimization, Tziola Publishing, 2014, in Greek | | | | |
| | 2. H. Taha, Operational Research, Tziola Publishing, 2007, translation in Greek | | | | |
| **Teaching and learning methods** | **LECTURES** | **RECITATION** | **LAB/PRACTICE** | **PROJECT / HOMEWORK** | |
| | 3h/w | 0 h/w | 0 h/w | 1/semester | |
| **Assessment type** | Combined | | | | |
| **Assessment and grading methods** | Final exam, weekly projects. | | | | |
| **Instruction Language** | Greek | | | | |
| **Erasmus availability** | NO | | | | |
| **Module URL** | https://eclass.upatras.gr/courses/CMNG2188/ | | | | |
| **Last Amendment** | December 2016 | | | | |

Bioreactor Analysis and Design

| | | | | | |
|---|---|---|---|---|---|
| **Module code** | **CHM_E_A3** | | | | |
| **Module title** | ***Bioreactor Analysis and Design*** | | | | |
| **Status**[3] | Live | | **Type** | Elective | |
| **Category A** | Adv. Chem. Engineering (Depth) | | | **%** | 100% |
| **Category B** | Choose Module Category B | | | **%** | % |
| **Year of study** | 5 | | **Semester** | Fall | |
| **ECTS credits** | 4 | | **Teaching Units** | 3 | |
| **Name of lecturer** | Stavros Pavlou | | | | |
| **Learning outcomes** | **CAT** | **Description** | | | |
| | A | Application of knowledge of basic biology, reaction engineering and biokinetics in designing and analyzing systems of bioreactors. | | | |
| | B | Application of mathematical and computational methods of analyzing and solving systems of differential equations representing mathematical models of bioreactors. | | | |
| | C | Constuction and computational analysis of mathematical models of systems of bioreactors. | | | |
| **Competences Prerequisites** | Knowledge of basic biology, principles of bioengineering, reaction engineering, mathematical and computational methods of analyzing and solving systems of differential equations. | | | | |
| **Module content** | BIOREACTORS. Chemostat, Monod's model in the chemostat. Product formation. Maintenance and endogenous metabolism. Non-ideal bioreactors. Cell attachment to chemostat walls.<br>DYNAMIC BEHAVIOR OF BIOREACTORS. Elements of system dynamics. Dynamic behavior of the chemostat. Monod's model. Andrews's model.<br>LIMITATION OF THE MICROBIAL GROWTH RATE FROM MULTIPLE NUTRIENTS. Classification of pairs of nutrients. Complementary nutrients. Substitutable nutrients. Generalized models of microbial growth.<br>DISTRIBUTED MODELS. Population balance of particles. Breakage process. Aggregation process. Balance of environmental components. Cell population balance in a chemostat.<br>MIXED CULTURES OF MICROORGANISMS. Classification of microbial interactions. Direct microbial interactions. Indirect microbial interactions. Combinations of interactions. | | | | |
| **Recommended literature** | 1. Σ. Παύλου, Μαθηματικά μοντέλα μικροβιακής ανάπτυξης σε βιοαντιδραστήρες, Εκδόσεις Πανεπιστημίου Πατρών | | | | |
| **Teaching and learning methods** | **LECTURES** | **RECITATION** | **LAB/PRACTICE** | **PROJECT / HOMEWORK** | |
| | 3 h/w | 0 h/w | 0 h/w | 10/semester | |
| **Assessment type** | Combined | | | | |
| **Assessment and grading methods** | Homework sets 20%<br>Final exam 80% | | | | |
| **Instruction Language** | Greek | | | | |
| **Erasmus availability** | NO | | | | |
| **Module URL** | https://eclass.upatras.gr/courses/CMNG2192/ | | | | |
| **Last Amendment** | January 2017 | | | | |

## Heterogeneous Catalysis

| | | | | |
|---|---|---|---|---|
| **Module code** | **CHM_E_B1** | | | |
| **Module title** | ***Heterogeneous Catalysis*** | | | |
| **Status** | Live | **Type** | Elective | |
| **Category A** | Adv. Chem. Engineering (Depth) | | **%** | 100% |
| **Category B** | Choose Module Category B | | **%** | % |
| **Year of study** | 5 | **Semester** | Fall | |
| **ECTS credits** | 4 | **Teaching Units** | 3 | |
| **Name of lecturer** | Symeon Bebelis | | | |

| | | |
|---|---|---|
| **Learning outcomes** | **CAT** | **Description** |
| | A | Knowledge of the fundamentals of thermodynamics and kinetics of the heterogeneous catalytic reactions. |
| | A | Knowledge of the basic types of solid catalysts and of the most common methods used for their synthesis, characterization and assessment of performance. |
| | A | Knowledge at the microscopic level of the general mechanism and of the basic aspects of chemisorption and catalytic action, for different types of solid catalysts. |
| | A | Knowledge of the key features of the heterogeneous catalytic actions in selected processes of industrial and environmental significance |
| | B | Ability to analyze experimental data of physisorption and chemisorption on solid catalyst surfaces and to identify the basic features of the mechanism of a heterogeneous catalytic reaction, on the basis of kinetic measurements and data resulting from the application of techniques of characterization of solid catalysts. |
| | F | Ability to select the most suitable type of heterogeneous catalyst for a particular reaction and become involved in development of new or optimized catalysts. |
| | K | Ability to clearly present in written as well as discuss solutions to homework exercises and problems related to heterogeneous catalysis. |

| | |
|---|---|
| **Competences Prerequisites** | There are no prerequisite modules. The students should have a basic knowledge of General and Inorganic Chemistry, Organic Chemistry, Physical Chemistry and Chemical Thermodynamics and Kinetics. |
| **Module content** | Introduction to Catalysis. Thermodynamics and kinetics of surface catalyzed reactions.<br>Basic physical forms of catalytic surfaces: Metal catalysts, microporous solids, supported liquid phase catalysts, immobilized and anchored catalysts, grafted catalysts, mixed oxide catalysts. Synthesis and characterization of solid catalysts.<br>Chemisorption processes at solid surfaces: Metal surfaces, redox oxide surfaces, solid acid surfaces.<br>The detection of adsorbates on catalyst surfaces. Techniques used to investigate phenomena at solid surfaces (TPD, TPR, SIMS, LEED, EELS, AES, UPS, XPS, EXAFS, IR and IRAS). General principles underlying each of these techniques and examples of their application in Heterogeneous Catalysis.<br>Catalytic actions on solid surfaces: Reactions catalyzed by transition metals, oxidation reactions on redox catalysts, hydrocarbon conversions on solid acid surfaces, reforming catalysts.<br>Fundamental aspects of the catalytic action in heterogeneous catalytic processes of industrial and environmental significance: Hydrogenation of vegetable oils. Ammonia and nitric acid production. Methanol synthesis. Synthesis gas conversion processes. Ethylene oxide production. Sulphuric acid production. Linear polyethylene production. Catalytic cracking. Synthetic gasoline production. Catalytic processes with modified zeolite catalysts. Catalytic processes for pollution abatement. |

| Module code | CHM_E_B1 | | | |
|---|---|---|---|---|
| | ***Keywords***: Heterogeneous Catalysis; Adsorption; Catalytic action; Catalytic processes; Catalyst characterization | | | |
| **Recommended literature** | 1. Lecture notes (Σ. Μπεμπέλης, Σ. Λαδάς, «Ετερογενής Κατάλυση», Πανεπιστήμιο Πατρών 2006) | | | |
| **Teaching and learning methods** | **LECTURES** | **RECITATION** | **LAB/PRACTICE** | **PROJECT / HOMEWORK** |
| | 3 h/w | 0 h/w | 0 h/w | 2/semester |
| **Assessment type** | Combined | | | |
| **Assessment and grading methods** | 1. *Final written exam*<br>The written exams comprise mainly theoretical questions (part of them in the form of multiple-choice questions) but also solving of simple exercises.<br>2. *Mid-term written exam (on volunteer basis)*<br>The mid-term exam grade is taken into account only if it is higher than that of the final exam.<br>3. *Homework assignments* (two homework sets), on volunteer basis. | | | |
| **Instruction Language** | Greek | | | |
| **Erasmus availability** | NO | | | |
| **Module URL** | https://eclass.upatras.gr/courses/CMNG2147/ | | | |
| **Last Amendment** | January 2017 | | | |

## Molecular Spectroscopy

| **Module code** | **CHM_E_B2** | | | |
|---|---|---|---|---|
| **Module title** | ***Molecular Spectroscopy*** | | | |
| **Status** | Live | **Type** | Elective | |
| **Category A** | Adv. Chem. Engineering (Breadth) | | **%** | 100% |
| **Category B** | Choose Module Category B | | **%** | % |
| **Year of study** | 5 | **Semester** | Fall | |
| **ECTS credits** | 4 | **Teaching Units** | 3 | |
| **Name of lecturer** | Soghomon Boghosian | | | |

| **Learning outcomes** | **CAT** | **Description** |
|---|---|---|
| | A | At the end of this module, students should be able to: understand the concepts of absorption, stimulated and spontaneous emission of radiation |
| | A | Explain the general principles and describe the instrumentation of rotational and vibrational spectroscopies |
| | A | Apply basic concepts to predict the appearance of microwave, IR and UV-vis spectra of organic and inorganic molecules |
| | A | Show familiarity with character tables and symmetry group operations, and distinguish between infrared and Raman active vibrations |
| | A | Apply molecular spectroscopy in research experiments to determine appropriate experimental methods that are most relevant to a specific problem |
| **Competences Prerequisites** | The students should have completed successfully the module CHM_421 (Physical Chemistry). | |
| **Module content** | - Introduction to Molecular Spectroscopy. The electromagnetic spectrum. Interaction of light and matter. Classification of spectra: emission, absorption and Raman spectra. Experimental techniques. The intensities and widths of spectral lines. | |

| **Module code** | **CHM_E_B2** | | | |
|---|---|---|---|---|
| | - Pure Rotational Spectra – Microwave Spectroscopy. Rotational constant, moment of inertia and rotational energy levels of diatomic molecules. Rotational transitions and selection rules. Rotational spectra of polyatomic molecules. Microwave spectroscopy. Rotational Raman spectra.<br>- Vibrational Spectroscopy – Diatomic Molecules. The vibrations of diatomic molecules. The harmonic oscillator. Selection rules and infrared spectra of diatomic molecules. Anharmonicity. Vibration-rotation spectra. Vibrational Raman spectra.<br>- Symmetry. The symmetry elements of objects. Symmetry operations. The symmetry classification of molecules. Introduction to the group theory.<br>- Vibrational Spectroscopy – Polyatomic Molecules. The vibrations of polyatomic molecules. Normal modes and symmetry. Infrared spectra and vibrational Raman spectra of polyatomic molecules. Applications of symmetry and group theory in spectroscopy.<br>- Electronic Spectroscopy. Electronic structure of molecules. Characteristics of electronic transitions. The Frank-Condon principle. UV/vis spectroscopy. Measures of intensity; the Beer-Lambert law. Introduction to Lasers. General principles of laser action. | | | |
| **Recommended literature** | 1. P.W. Atkins and J. de Paula, "Physical Chemistry", 9th Edition, Oxford University Press, 2010 (Greek translation, 2014). | | | |
| | 2. Στέφανος Τραχανάς, "Στοιχειώδης Κβαντική Φυσική", Πανεπιστημιακές Εκδόσεις Κρήτης, 2012. | | | |
| | 3. N.A. Κατσάνος, "Φυσικοχημεία, Βασική θεώρηση", Εκδόσεις Παπαζήση. | | | |
| **Teaching and learning methods** | **LECTURES** | **RECITATION** | **LAB/PRACTICE** | **PROJECT / HOMEWORK** |
| | 3 h/w | 0 h/w | 0 h/w | 5/semester |
| **Assessment type** | Written Examination | | | |
| **Assessment and grading methods** | | | | |
| **Instruction Language** | Greek | | | |
| **Erasmus availability** | NO | | | |
| **Module URL** | https://eclass.upatras.gr/courses/CMNG2173/ | | | |
| **Last Amendment** | December 2016 | | | |

## Surface Science

| **Module code** | **CHM_E_B3** | | | |
|---|---|---|---|---|
| **Module title** | ***Surface Science*** | | | |
| **Status** | Live | **Type** | Elective | |
| **Category A** | Adv. Chem. Engineering (Breadth) | | **%** | 100% |
| **Category B** | Choose Module Category B | | **%** | % |
| **Year of study** | 5 | **Semester** | Fall | |
| **ECTS credits** | 4 | **Teaching Units** | 3 | |
| **Name of lecturer** | Spyridon Ladas | | | |
| **Learning outcomes** | **CAT** | **Description** | | |
| | A | Apply concepts and methods of Physics and Chemistry of Solids in understanding the behavior of surfaces and interfaces in Materials Engineering processes. | | |
| | B | Ability to handle and interpret experimental data from various surface analysis and characterization techniques. | | |

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

## Production & Shaping of Industrial Materials

| Module code | CHM_E_Γ1 | | | |
|---|---|---|---|---|
| Module title | ***Production & Shaping of Industrial Materials*** | | | |
| Status | Live | Type | Elective | |
| Category A | Adv. Chem. Engineering (Depth) | | % | 50% |
| Category B | Adv. Chem. Engineering (Breadth) | | % | 50% |
| Year of study | 5 | Semester | Fall | |
| ECTS credits | 4 | Teaching Units | 3 | |
| Name of lecturers | George Angelopoulos, Yannis Dimakopoulos, Panagiotis Nikolopoulos,Victor Stivanakis | | | |
| Learning outcomes | CAT | Description | | |
| | D | To use chemical and physical methods for producing metals | | |
| | D | To be able to control the processing variables for the melts of industrial materials | | |
| | D | To be able to take samples from the process and make test and analysis | | |
| | G | To be able to investigate if the methods are economical,efficient and environmentally acceptable | | |

| Module code | CHM_E_Γ1 | | | |
|---|---|---|---|---|
| Competences Prerequisites | - | | | |
| Module content | ***1) Production of Iron and Steel (G.Aggelopoulos, 3-4 lectues):***<br>Iron and steel production. Iron ore. From iron ore to steel. Reduction of minerals,coke, blast furnace. Reduction reactions. Ellingham diagrams. Boudouard equilibrium and Chaudron curves. Mass balance in the blast furnace. Cast iron and categories. Pretreatment of iron. The making of steel. Refining processes. Reactions refining. Processes of oxygen. Electric arc furnace. Categories and classification steels.<br><br>***2) Production /Formatting Polymeric Materials (Y.Dimakopoulos,3-4 lectures ):***<br>*Part 1: Basic Principles of Polymer Processing (1-2 weeks)*<br>Historical Background: • From Natural to Synthetic Rubber • Cellulose and the $10,000 Idea•Galalith - The Milk Stone•Leo Baekeland and the Plastics Industry•Herman Mark and the American Polymer Education•Wallace Hume Carothers and Synthetic Polymers•Polyethylene - A Product of Brain and Brawn•The Super Fiber and the Woman Who Invented it• One Last Word - Plastics<br>Structure of Polymers: • Structure of Polymers• Macromolecular• Conformation and Configuration of Polymer Molecules• Arrangement of Polymer Molecules• Copolymers and Polymer Blends• Polymer Additives<br>Thermal Properties of Polymers: • Material Properties • Measuring Thermal Data<br>Rheology of Polymer Melts: • Viscous Flow Models• Simplified Flow Models Common in Polymer Processing • Viscoelastic Flow Models • Rheometry• Surface Tension<br><br>*Part 2: Influence of Processing on Properties: Introduction to Processing (3-4 weeks)*<br>Historical Background:• Extrusion• Mixing Processes• Injection Molding• Special Injection Molding Processes• Secondary Shaping• Calendering• Coating• Compression Molding• Foaming• Rotational Molding<br>Anisotropy Development During Processing: •Orientation in the Final Part •Predicting Orientation in the Final Part • Fiber Damage<br>Solidification of Polymers: •Solidification of Thermoplastics• Solidification of Thermosets• Residual Stresses and Warpage of Polymeric Parts<br><br>***3) Surface Treatments of Iron and Galvanisation(B.Stivanakis,1 lecture):***<br>Methods of galvanisation, Intermetallic phases Fe-Z<br><br>***4) Inorganic binders Materials -Cements(B.Stivanakis,2-3 lectures):***<br>Technology cement manufacturing, Admixtures and cement, Technology to address environmental impacts, Environmental cement footprint<br><br>***5) Ceramics(P.Nikolopoulos,3-4 lectures):***<br>Introduction to Ceramics, Production of ceramic powders, Formatting and aggregation (sintering) Ceramics, properties of Ceramics, Failure Analysis Ceramics, Applications Ceramics [Traditional, Technical and Advanced Ceramics (structural and functional)] , Joining Materials (cermet) | | | |
| Recommended literature | 1. Lorraine F. Francis, “Materials Processing:A Unified Aproach to Processinf of Metals, Ceramics, and Polymers”,1st Edition,Academic Press, 2016 | | | |
| Teaching and learning methods | LECTURES | RECITATION | LAB/PRACTICE | PROJECT / HOMEWORK |
| | 3 h/w | 0 h/w | 0 h/w | 2/semester |
| Assessment type | During the semester | | | |
| Assessment and grading methods | Describe assessment methods and module mark calculation | | | |
| Instruction Language | Greek | | | |
| Erasmus availability | NO | | | |
| Module URL | Insert eclass address (mandatory for all modules) | | | |

| | |
|---|---|
| **Module code** | **CHM_E_Γ1** |
| **Last Amendment** | January 2017 |

## Nanomaterials & Nanotechnology

| | | | | |
|---|---|---|---|---|
| **Module code** | **CHM_E_Γ2** | | | |
| **Module title** | ***Nanomaterials & Nanotechnology*** | | | |
| **Status** | Live | **Type** | Elective | |
| **Category A** | Adv. Chem. Engineering (Depth) | | **%** | 50% |
| **Category B** | Adv. Chem. Engineering (Practice) | | **%** | 50% |
| **Year of study** | 5 | **Semester** | Fall | |
| **ECTS credits** | 4 | **Teaching Units** | 3 | |
| **Name of lecturers** | Costas Galiotis, Stella Kennou | | | |
| **Learning outcomes** | **CAT** | **Description** | | |
| | A | Nanomaterials and nanotechnology for engineering applications. | | |
| | D | Production and properties of a whole range of nanomaterials inclusive of nanostructured polymers and nanocomposites materials. | | |
| **Competences Prerequisites** | There are no prerequisite modules. It is however, recommended that students should have knowledge of the basic principles of Materials Science. | | | |
| **Module content** | A. Introduction. Historical perspective. Advantages and applications of nanotechnology. Future perspectives.<br>B. Brief description of electronic, mechanical, electrical, magnetic and optical properties of materials. Influence of the nanoscale on these properties.<br>C. Classification of the nanomaterials as zero-, one- and two- dimensional Nanostructures (nano particles, nano wires/ nanotubes /nano rods, graphene and other 2D materials. Properties and applications.<br>D. Overview of Nano Fabrication Methods: Top-down and bottom-up approaches, lithography, deposition, CVD, PVD, wet etching, dry etching and material modification methods, pattern transfer methods processes and equipment.<br>E. Nanostructured polymers- Methods and polymerization technics which can be used for the synthesis of block and graft copolymers, suitable for the creation of nanostructured systems. Study of the phase separation of block copolymers, micro-phase separation, appearance of nanostructures. Exploitation of the micro-phase separation of the block copolymers for the creation of useful nanostructures.<br>F. Nanocomposite materials- types of inclusions, type of matrices, dispersion of inclusions, modification of matrix at nanoscale, production methods (shear mixing, centrifugal mixer, extrusion etc). Properties (electrical, mechanical, etc.) and applications.<br>G. Characterization Methods and Tools- Optical microscopy, Profilometry, Ellipsometry, IR and Raman spectroscopies, Scanning Electron, Microscope, AFM etc..<br>H. Application of nano materials, Carbon Nano Tubes, Quantum dots, Graphene, Organic compounds etc | | | |
| **Recommended literature** | 1. Lecture notes | | | |
| **Teaching and learning methods** | **LECTURES** | **RECITATION** | **LAB/PRACTICE** | **PROJECT / HOMEWORK** |
| | 3 h/w | 0 h/w | 0 h/w | 1/semester |
| **Assessment type** | Combined | | | |
| **Assessment and grading methods** | 1. Written examination (50% of total mark)<br>2. Individual project per student on a specific nanotechnology topic (50% of total mark). | | | |

| | |
|---|---|
| **Module code** | **CHM_E_Γ2** |
| **Instruction Language** | Greek |
| **Erasmus availability** | YES |
| **Module URL** | https://eclass.upatras.gr/courses/CMNG2200 |
| **Last Amendment** | January 2017 |

Biomaterials

<table>
<tr><td>Module code</td><td colspan="4">CHM_E_Γ3</td></tr>
<tr><td>Module title</td><td colspan="4">Biomaterials</td></tr>
<tr><td>Status</td><td colspan="2">Live</td><td>Type</td><td>Elective</td></tr>
<tr><td>Category A</td><td colspan="2">Adv. Chem. Engineering (Breadth)</td><td>%</td><td>100%</td></tr>
<tr><td>Category B</td><td colspan="2">Choose Module Category B</td><td>%</td><td>%</td></tr>
<tr><td>Year of study</td><td colspan="2">5</td><td>Semester</td><td>Fall</td></tr>
<tr><td>ECTS credits</td><td colspan="2">3</td><td>Teaching Units</td><td>3</td></tr>
<tr><td>Name of lecturers</td><td colspan="4">Eleftherios Amanatides, Constantinos Tsitsilianis</td></tr>
<tr><td rowspan="8">Learning outcomes</td><td>CAT</td><td colspan="3">Description</td></tr>
<tr><td>F</td><td colspan="3">The meanings of biocompatibility and toxicity of biomaterials</td></tr>
<tr><td>F</td><td colspan="3">The different types of biomaterials depending on the biomedical application and the most important mechanical, physicochemical and biological properties of these materials.</td></tr>
<tr><td>J</td><td colspan="3">The most important mechanisms of cells response to wounds caused by biomaterials implantation</td></tr>
<tr><td>F</td><td colspan="3">The most important in-vitro and in-vivo test of biomaterials for monitoring their biocompatibility and toxicity</td></tr>
<tr><td>J</td><td colspan="3">The most important mechanisms of cells response to wounds caused by biomaterials implantation</td></tr>
<tr><td>F</td><td colspan="3">The most important types of biomaterials infection and prevention methods</td></tr>
<tr><td>D</td><td colspan="3">The main methods and techniques for drug delivery control and targeting</td></tr>
<tr><td>Competences Prerequisites</td><td colspan="4">There are no prerequisite modules. It is, however, recommended that students should have basic knowledge of Materials Science, Polymers Science and Biology</td></tr>
<tr><td>Module content[7]</td><td colspan="4">A. Introduction to biomaterials and biocompatibility / toxicity. 1st, 2nd and 3d generation biomaterials. Replacement, Reconstruction and regeneration of basic organs<br>B. Types of biomaterials: Synthesis and properties of metallic, ceramic and polymeric biomaterials Mechanical and physicochemical properties . Hydrogels, Natural Biomaterials, medical fibers and textiles.<br>C. Methods for surface modification of biomaterials.<br>D. Proteins – Cells – Tissues: Mechanisms of interactions with biomaterial surfaces. Cells and tissue responses to implantation wounds<br>E. Biomaterials Infection. Main types and prevention methods<br>F. Biomaterials for drug delivery applications<br>G. FDA approvals and CE marking rules and classifications of biomaterials</td></tr>
<tr><td rowspan="2">Recommended literature</td><td colspan="4">1. Biomaterials Science: An Introduction to Materials in Medicine, Second Edition [electronic resource] - 2nd edition/2004 - Author: Ratner, B. D.- ISBN: 978-0125824637, Type: Electronic book</td></tr>
<tr><td colspan="4">2. Biomaterials [electronic resource], Authors: Park, Joon and Lakes, R.S., ISBN: 9780387378800, Type: Electronic book</td></tr>
</table>

| Module code | CHM_E_Γ3 | | | |
|---|---|---|---|---|
| | 3. Biomaterials The Intersection of Biology and Materials Science, J. S. Temenoff, A. G. Mikos ISBN 978-0-13-009710-1 | | | |
| Teaching and learning methods | LECTURES | RECITATION | LAB/PRACTICE | PROJECT / HOMEWORK |
| | 3 h/w | 0 h/w | N0 h/w | 1/semester |
| Assessment type | Combined | | | |
| Assessment and grading methods | 1. One project per group of one or two students in a specific biomaterials topic (50 % of final grade). The students presents their project and deliver a 10 pages summary of the project<br>2. Final written exams (50 % of final grade) | | | |
| Instruction Language | Greek | | | |
| Erasmus availability | YES | | | |
| Module URL | https://eclass.upatras.gr/courses/CMNG2117/ | | | |
| Last Amendment | December 2016 | | | |

## 3.11 5th Year – 10th Semester

### Applications & Simulation of Transport Phenomena

| Module code | CHM_E69 | | | |
|---|---|---|---|---|
| Module title | ***Applications & Simulation of Transport Phenomena*** | | | |
| Status | Live | Type | Elective | |
| Category A | Adv. Chem. Engineering (Depth) | | % | 100% |
| Category B | Choose Module Category B | | % | % |
| Year of study | 5 | Semester | Spring | |
| ECTS credits | 4 | Teaching Units | 3 | |
| Name of lecturer | Yannis Dimakopoulos | | | |
| Learning outcomes | CAT | Description | | |
| | A | The basics of computational transport phenomena | | |
| | B | How to discretize 3d spaces and construct high quality meshes | | |
| | B | How to solve realistic problems | | |
| | C | Develop a student's ability for result presentations and data visualization of engineering problems. | | |
| Competences Prerequisites | Prerequisite modules have not been set. The students however, must have good knowledge of Fluid Mechanics, Heat & Mass Transfer, Numerical Methods | | | |
| Module content[7] | 1) Introduction to Finte Volume, Finite Element, and Finite Difference Methods<br>2) Mesh Generation<br>Unstructured vs structured mesh, assessment of mesh quality, effect of element shape on accuracy and stability, false diffusion due to mesh alignment, types of boundary conditions, computational assignment using CAE tool.<br>3) Momentum Transport in Laminar Flows<br>Introduction to Navier-Stokes (NS) equations in dimensional and non-dimensional form, special cases of creeping and inviscid flows, iterative and non-iterative methods for numerical solution of NS equations (SIMPLE, PISO, FSM methods), computational assignment using CAE tool.<br>4) Heat Conduction and Convection in Laminar Flows | | | |

| Module code | CHM_E69 | | | |
|---|---|---|---|---|
| | Steady and unsteady heat condition equations, natural and forced convection in laminar flows, introduction to relevant non-dimensional numbers, difficulties faced in numerical solution of energy equation, coupling of energy and momentum equations, computational assignment using CAE tool.<br>4) Mass Transport in Laminar Flows<br>Fick's law of mass diffusion, equations of change for multi-component gas-phase diffusive and convective mass transport, introduction to relevant non-dimensional numbers, solution procedure for mass transport equation, computational assignment using CAE tool<br>5) Introduction to Turbulent Flows<br>Practical examples of turbulent flows, statistical description of turbulent flows, scales of turbulent motion, transition from laminar to turbulent flows, examples of free shear flows and wall flows<br>6) Introduction to Simulations of Turbulent Flows<br>Turbulence modelling approaches (RANS, LES, DNS), choice of an approach based on computational cost and relevant physics, examples of most commonly used turbulence models, computational assignments using CAE tool<br>7) Introduction to OpenFoam<br>8) Applications with OpenFoam | | | |
| **Recommended literature** | 1. H. K. Versteeg and W. Malalasekera, 'An Introduction to Computational Fluid Dynamics: the Finite Volume Method', Longman Scientific & Technical, 2007 (Translation in Greek, 2015). | | | |
| | 2. J. H. Ferziger and M. Peric, 'Computational Methods for Fluid Dynamics', Springer, 2004. | | | |
| | 3. C. Hirsch, 'Numerical Computation of Internal and External Flows: Volume 1, Fundamentals of Numerical Discretization', 2nd Edition, John Wiley & Sons, 2001. | | | |
| **Teaching and learning methods** | **LECTURES** | **RECITATION** | **LAB/PRACTICE** | **PROJECT / HOMEWORK** |
| | 3 h/w | 0 h/w | 0 h/w | 6/semester |
| **Assessment type** | During the semester | | | |
| **Assessment and grading methods** | 1. Exercises (45% of the final grade).<br>2. Research Project based on the recent scientific literature (55%) | | | |
| **Instruction Language** | Greek | | | |
| **Erasmus availability** | YES | | | |
| **Module URL** | https://eclass.upatras.gr/modules/auth/opencourses.php?fc=59 | | | |
| **Last Amendment** | January 2017 | | | |

## Solid Wastes Management

| Module code | CHM_E_A5 | | | |
|---|---|---|---|---|
| **Module title** | ***Solid Wastes Management*** | | | |
| **Status** | Live | **Type** | Elective | |
| **Category A** | Adv. Chem. Engineering (Breadth) | | **%** | 100% |
| **Category B** | Choose Module Category B | | **%** | % |
| **Year of study** | 5 | **Semester** | Spring | |
| **ECTS credits** | 4 | **Teaching Units** | 3 | |
| **Name of lecturer** | Michael Kornaros | | | |
| **Learning outcomes** | **CAT** | **Description** | | |
| | A | Ability to apply mass and energy balances to solid waste management processes | | |

| Module code | CHM_E_A5 | |
|---|---|---|
| | D | Knowledge of mass and energy balances and unit operations as they apply in thermal and biological processes of solid waste managament |
| | E | Ability to design and assess mechanical, chemical and biological processes for integrated solid waste management |
| | F | Abiity to develop and implement new technologies and methods pertaining in solid waste management |
| **Competences Prerequisites** | There are no prerequisites for this module. However, students should have basic knowledge of mass and energy balances and unit operations. | |
| **Module content** | Qualitative and quantitative characteristics of solid wastes. Integrated solid waste management. Special wastes. Source sorting and recycling. Design of solid waste collection systems. Mechanical separation into fractions. Landfill design, operation and closure. Thermal conversion processes (incineration, pyrolysis, gasification). Biological conversion processes (composting, anaerobic digestion). Economic and environmental assessment of alternative integrated solid management scenarios. | |
| **Recommended literature** | 1. "Βιώσιμη Διαχείριση Αστικών Στερεών Αποβλήτων", Δ. Χ. Παναγιωτακόπουλος, Εκδ. Ζυγός, 2007, 2η Εκδοση, Θεσσαλονίκη, ISBN: 978-960-8065-31-4 | |
| | 2. "Εγχειρίδιο Διαχείρισης Στερεών Αποβλήτων", G. Tchobanoglous, F. Kreith. Μετάφραση: Α. Κούγκολος, Α. Καραγιαννίδης, Π. Σαμαράς, Εκδ. Τζιόλα, 2010, 2η Εκδοση, Θεσ/νίκη. ISBN 978-960-418-247-3 | |

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

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

## Air Pollution Management

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

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

| Module code | CHM_E_A6 | | | |
|---|---|---|---|---|
| Competences Prerequisites | Chemical Thermodynamics; Transport Phenomena; Reaction Engineering | | | |
| Module content | The Atmosphere. History and development, atmospheric layers, pressure change with altitude, atmospheric composition, transport times in the atmosphere, major gas-phase pollutants, atmospheric particulate matter, toxics, standards and regulations.<br>Tropospheric chemistry. Basic photochemical cycle of $NO_2$, NO and $O_3$, atmospheric chemistry of CO, formaldehyde chemistry, chemistry of the clean atmosphere, tropospheric ozone, the role of organic compounds and $NO_x$ in ozone formation.<br>Aqueous-phase chemistry. Water in the atmosphere, absorption of pollutants in clouds, sulfuric acid formation, nitric acid formation.<br>Atmospheric particulate matter. Chemical composition and size distribution, thermodynamic principles, water and particulate matter, thermodynamics of atmospheric particles, organic components of aerosols, primary and secondary aerosols.<br>Wet deposition and acid rain General principles, collection of gas-phase pollutants by rain, collection of particles by rain, acid deposition, synthesis of processes leading to acid deposition. | | | |
| Recommended literature | 1. Λαζαρίδης Μ., Ατμοσφαιρική Ρύπανση με Στοιχεία Μετεωρολογίας, 2η έκδοση, Εκδ. Τζιόλα, 2010. | | | |
| | 2. Γεντεκάκης Ι., Ατμοσφαιρική Ρύπανση, Κλειδάριθμος, 2010. | | | |
| | 3. Seinfeld J. H. and Pandis S. N., Atmospheric Chemistry: Air Pollution to Global Change, 2nd edition, John Wiley and Sons, New York, 2006. | | | |
| Teaching and learning methods | LECTURES | SEMINARS | LAB/PRACTICE | PROJECT / HOMEWORK |
| | 3 h/w | 0 h/w | 0 h/w | 6/semester |
| Assessment type | Combined | | | |
| Assessment and grading methods | The final grade is 40% of the grade of homeworks and 60% of the grade of the final exam. | | | |
| Instruction Language | Greek and English | | | |
| Erasmus availability | YES | | | |
| Course URL | https://eclass.upatras.gr/courses/CMNG2119/ | | | |
| Last Amendment | January 2017 | | | |

## Reactor Analysis and Design

| Module code | CHM_E_B4 | | | |
|---|---|---|---|---|
| Module title | ***Reactor Analysis and Design*** | | | |
| Status | Live | Type | Elective | |
| Category A | Adv. Chem. Engineering (Depth) | | % | 100% |
| Category B | Choose Module Category B | | % | % |
| Year of study | 5 | Semester | Spring | |
| ECTS credits | 4 | Teaching Units | 3 | |
| Name of lecturer | Symeon Bebelis, Dimitrios Spartinos | | | |
| Learning outcomes | CAT[5] | Description | | |
| | D | A good understanding of the operation of basic heterogeneous chemical reactors. | | |
| | D | Familiarization with the models which have been proposed for the simulation of catalytic reactors and their basic principles. | | |

| Module code | CHM_E_B4 | | | |
|---|---|---|---|---|
| | D | Knowledge in depth of the basic pseudo-homogeneous model for fixed bed reactors | | |
| | D | Ability to understand basic principles of analysis and design of heterogeneous catalytic reactors. | | |
| | C | Ability to design fixed bed reactors with simple pseudo-homogeneous models. | | |
| **Competences Prerequisites** | Chemical Reaction Engineering I and II | | | |
| **Module content[7]** | Algorithms for the numerical solution of differential equations<br>Mass, energy and momentum balances applied to chemical reactors.<br>Pseudo-homogeneous models of heterogeneous reactors.<br>Isothermal and adiabatic reactors<br>Polytropic reactors. | | | |
| **Recommended literature** | 1. X. E. Verykios “Heterogeneous Catalytic Reactions and Reactors”, Costarakis Press, Athens, in Greek. | | | |
| | 2. G. F. Froment and K. B. Bischoff, “ Chemical Reactor Analysis and Design”, John Wiley, New York 1979 | | | |
| | 3. J. M. Smith, “Chemical Engineering Kinetics”, McGraw-Hill, New York 1981. | | | |
| **Teaching and learning methods** | **LECTURES** | **RECITATION** | **LAB/PRACTICE** | **PROJECT / HOMEWORK** |
| | 3 h/w | 0 h/w | 0 h/w | 0/semester |
| **Assessment type** | Written Examination | | | |
| **Assessment and grading methods** | Solution of problems all through the semester.<br>Final examination | | | |
| **Instruction Language** | Greek | | | |
| **Erasmus availability** | NO | | | |
| **Module URL** | | | | |
| **Last Amendment** | January 2017 | | | |

## Electrochemical Processes

| Module code | CHM_E_B5 | | | |
|---|---|---|---|---|
| **Module title** | ***Electrochemical Processes*** | | | |
| **Status** | Live | **Type** | Elective | |
| **Category A** | Adv. Chem. Engineering (Depth) | | **%** | % |
| **Category B** | Choose Module Category B | | **%** | % |
| **Year of study** | 5 | **Semester** | Spring | |
| **ECTS credits** | 4 | **Teaching Units** | 3 | |
| **Name of lecturer** | Symeon Bebelis | | | |
| **Learning outcomes** | **CAT** | **Description** | | |
| | A | Ability to describe the modes of operation of electrochemical systems, the different types of ionic conductors, the interactions between ions in electrolytic solutions and the fundamental parameters and laws which concern ion transfer and electrical conduction in a homogeneous electrolyte phase. | | |
| | A | Ability to describe the structure of an electrode/electrolyte interphase and explain the appearance of potential difference across it, as well as to formulate the | | |

| Module code | CHM_E_B5 | | | |
|---|---|---|---|---|
| | | condition of thermodynamic equilibrium for an electrode/electrolyte interphase or an electrochemical reaction. | | |
| | A | Ability to describe the factors and mechanisms which determine the rate of an electrochemical reaction and control the operation of electrochemical systems under non-equilibrium conditions, as well as to express the rate of a multistep electrochemical reaction as a function of measurable parameters. | | |
| | B | Ability to explain and implement equations for calculation of the ionic strength, activity coefficients, conductivity and related parameters in electrolyte solutions, as well as of the conductivity temperature dependence in electrolyte melts and solid electrolytes. | | |
| | B | Ability to explain and implement equations for calculation of the standard emf of an electrochemical cell using standard electrode potentials data or thermodynamic data, for correlation of the equilibrium electrode potential or the emf with the activities of the electroactive species, and for prediction of the spontaneous direction of a redox reaction using electrochemical data. | | |
| | B | Ability to explain and implement equations for calculation of the overpotentials developing during operation of an electrochemical cell as well of the operating potential of the cell, for a given current density. | | |
| | K | Ability to clearly present in written as well as discuss solutions to homework exercises and problems related to electrochemical processes. | | |
| **Competences Prerequisites** | The students should have basic knowledge of Physical Chemistry, with focus on Chemical Thermodynamics and Chemical Kinetics. | | | |
| **Module content** | *Introduction to electrochemistry:* Electrochemical vs. purely chemical reactions. Electrolytic and galvanic cells.<br>*Ions and electrolytes*: Activities of ions in electrolyte solutions - Activity coefficients - Debye-Hückel theory. Mechanisms of ion transfer and electrical conduction in electrolyte solutions. Electrolyte melts. Solid electrolytes.<br>*Electrode/electrolyte interphases and electrochemical cells:* The structure of the electrode/electrolyte interphase and the potential difference across it. Polarizable and non-polarizable interphases. Reference electrodes. The electrochemical series. The IUPAC conventions for electrochemical cells and for the sign of electromotive force. Prediction of the spontaneous direction of redox reactions using electrode potential data.<br>*Thermodynamics of electrochemical reactions*: Electrochemical potential and electrochemical Gibbs free energy. Electrochemical equilibrium. The Nernst equation.<br>*Electrode kinetics*: The relation of current density to electrochemical reaction rate. Exchange current density. Faraday's laws of electrolysis. Effect of potential on the rate of an electrochemical reaction. Definition and measurement of electrode overpotential. Activation overpotential. The Butler-Volmer equation. The Tafel equation. Concentration overpotential and limiting current density. Ohmic overpotential. Operating potential of an electrochemical cell. Kinetic models for multistep electrochemical reactions.<br>*Electrocatalysis and Electrochemical Promotion of Catalysis:* Basic concepts | | | |
| **Recommended literature** | 1. Ν. Κουλουμπή, "Ηλεκτροχημεία", Εκδόσεις Συμεών, Αθήνα, 2005 | | | |
| | 2. Ι. Α. Μουμτζής και Δ. Π. Σαζού, "Ηλεκτροχημεία", Εκδόσεις Ζήτη, Θεσσαλονίκη, 1997 | | | |
| **Teaching and learning methods** | **LECTURES** | **RECITATION** | **LAB/PRACTICE** | **PROJECT / HOMEWORK** |
| | 3 h/w | 0 h/w | 0 h/w | 3-4 /semester |
| **Assessment type** | Combined | | | |
| **Assessment and grading methods** | 1. *Final written exam*<br>The written exams comprise mainly theoretical questions (part of them in the form of multiple-choice questions) but also solving of simple exercises. | | | |

| Module code | CHM_E_B5 |
|---|---|
| | 2. *Mid-term written exam (on volunteer basis)*<br>The mid-term exam grade is taken into account only if it is higher than that of the final exam.<br>3. *Homework assignments* (3-4 homework sets), on volunteer basis. |
| **Instruction Language** | Greek |
| **Erasmus availability** | NO |
| **Module URL** | https://eclass.upatras.gr/courses/CMNG2149/ |
| **Last Amendment** | January 2017 |

Suspensions and Emulsions

| **Module code** | **CHM_E_B6** | | | | |
|---|---|---|---|---|---|
| **Module title** | ***Suspensions and Emulsions*** | | | | |
| **Status** | Live | | **Type** | Elective | |
| **Category A** | Adv. Chem. Engineering (Breadth) | | | **%** | 100% |
| **Category B** | Choose Module Category B | | | **%** | % |
| **Year of study** | 5 | | **Semester** | Spring | |
| **ECTS credits** | 4 | | **Teaching Units** | 4 | |
| **Name of lecturer** | Christakis Paraskeva | | | | |
| **Learning outcomes** | **CAT** | **Description** | | | |
| | D | Acquaintance with dispersed systems (Definitions, preparation, characterization) | | | |
| | A | Deviation of electrolyte solutions from ideal behaviour. Ion-ion interactions. | | | |
| | A | Mechanism of development of surface charge on particles suspended in electrolyte solutions | | | |
| | F | Methods and techniques of measurement of surface charge of colloids suspended in electrolyte solutions | | | |
| | A | Films and Foams | | | |
| | D | Stability of colloid suspensions and of foams. Theoretical and practical aspects | | | |
| | A | Kinetics of destabilization of colloidal systems | | | |
| **Competences Prerequisites** | Prerequisites desired: Knowledge of electrolyte solutions theory | | | | |
| **Module content** | Dispersed matter. Liposomes and emulsions. The solid-liquid interface. DEBYE-HUCKEL theory for electrolytes. Extension to charged interfaces. The electrical double layer. Negative adsorption, Donnan equilibria and ion exchange. The point of zero charge. Thermodynamic analysis of the electrical double layer. The electrocapillary curve (Lippmann equation). Experimental measurements of the electro capillary curves and their significance for the electrical double layer parameters. Specific adsorption. Potentiometric titrations. Surface and ζ potential. Electrokinetic phenomena. Films and foams and their respective stability. The role of surfactants and drain. Repulsion between approaching double layers. Stability of lyophobic colloids. The DLVO theory. The Schultze-Hardy rule. The interaction between two particles. The Hamaker coefficient. The aggregation concentration | | | | |
| **Recommended literature** | 1. Κ. Παναγιώτου, Διεπιφανειακά Φαινόμενα & Κολλοειδή Συστήματα, Εκδ. Ζήτη, Θεσσαλονίκη, 1998 | | | | |
| | 2. Π.Κουτσούκος, Χημεία Κολλοειδών, Πανεπιστήμιο Πατρών 1996 | | | | |

| Module code | CHM_E_B6 | | | |
|---|---|---|---|---|
| Teaching and learning methods | LECTURES | RECITATION | LAB/PRACTICE | PROJECT / HOMEWORK |
| | 3 h/w | 0 h/w | 0 h/w | 5/semester |
| Assessment type | Written Examination | | | |
| Assessment and grading methods | Final mark based on the final written exam. Homework assignments are taken into consideration. | | | |
| Instruction Language | Greek and English | | | |
| Erasmus availability | YES | | | |
| Module URL | https://eclass.upatras.gr/courses/CMNG2128/ | | | |
| Last Amendment | June 2016 | | | |

## Microelectronics Technology

| Module code | CHM_E_Γ4 | | | |
|---|---|---|---|---|
| Module title | *Microelectronics Technology* | | | |
| Status | Live | Type | Elective | |
| Category A | Adv. Chem. Engineering (Breadth) | | % | 70% |
| Category B | Adv. Chem. Engineering (Depth) | | % | 30% |
| Year of study | 5 | Semester | Spring | |
| ECTS credits | 4 | Teaching Units | 4 | |
| Name of lecturer | Ergina Farsari | | | |
| Learning outcomes | CAT | Description | | |
| | A | Acquaintance with the specifics of Chemical and Physical processes used in microelectronics processing (CVD, PVD, MBE, Sputtering, PECVD, Etching) using the fabrication of Silicon IC's as a paradigm. | | |
| | D | Application of reactor design and transport phenomena in the microscopic processing steps of IC fabrication. | | |
| | D | Ability to apply Chemical Engineering Principles on a different scale in non-classical chemical engineering problems | | |
| Competences Prerequisites | Prerequisites desired: Materials Science, Chemical Kinetics, Reactor Design and Transport Phenomena. | | | |
| Module content | Introduction. Integrated Circuits (IC). Semiconductors and charge carriers, basic relationships. Elementary IC units, diodes and transistors, device physics and operation. Outline of IC production: from sand to IC's.<br>Metallurgical Grade Silicon production. Silicon refining, Electronic Grade Silicon. Production and refinement of chlorosilanes. Deposition of polycrystalline silicon: Siemens, fluidized bed.<br>Crystal Growth. Czochralski (CZ), Bridgeman and floating zone methods. Overview of CZ, axial and radial distribution of dopants and oxygen.<br>Chemical Processes. Chemical Vapor Deposition (CVD). Surface diffusion and epitaxial growth. Homogeneous and heterogeneous reactions and deposition kinetics. CVD reactors. Flow and heat regimes, reactor design.<br>Doping. Incorporation and transport of dopants. Diffusion in solids, redistribution of dopants.<br>Lithography. Basic principles and techniques. Resists and resist development.<br>Physical and Physicochemical Processes. Evaporation (PVD) and Molecular Beam Epitaxy (MBE). Plasma Processing. Sputtering (dc, rf), sputtering rates and deposition rate. Plasma | | | |

| | |
|---|---|
| **Module code** | **CHM_E_Γ4** |
| | Enhanced Chemical Vapor Deposition (PECVD). Plasma Etching. PVD and Plasma reactors: specifics, electrical characteristics and design considerations. |
| **Recommended literature** | 1. Fundamentals of Microelectronics Processing. Hong. H. Lee. McGraw-Hill. ISBN-0-07100796-2 |
| | 2. Process Engineering Analysis in Semiconductor Device Fabrication. S. Middleman, A. Hochberg, McGraw-Hill, ISBN-0-07041853-5 |

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

| | |
|---|---|
| **Assessment type** | Combined |
| **Assessment and grading methods** | Final mark based on the final written exam. 4 written tests and 2 homework assignments are taken into consideration. |
| **Instruction Language** | Greek and English |
| **Erasmus availability** | YES |
| **Module URL** | https://eclass.upatras.gr/courses/CMNG2103/ |
| **Last Amendment** | June 2016 |

## Corrosion and Materials Protection

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

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

| | |
|---|---|
| **Competences Prerequisites** | Basic knowledge of Physical Chemistry (with focusing on basic knowledge of Electrochemistry) Thermodynamics, Kinetics and Materials Science. |

| **Module code** | **CHM_E_Γ5** | | | |
|---|---|---|---|---|
| **Module content** | *A. Introduction to corrosion- Fundamental aspects:*<br>Definition, characteristics and importance of corrosion. The thermodynamic aspects of corrosion. The electrochemical theory of corrosion. Galvanic couples. Mixed potentials. Mechanism of oxidation of metals in aqueous solutions. Reduction reactions accompanying the corrosion of metals. Corrosion tendency of materials and factors affecting the corrosion rate. Measurement of corrosion and investigation of corrosion mechanism (parameters, methods). Construction and use of (thermodynamic) Pourbaix diagrams and (kinetic) Evans diagrams. Mechanism of iron corrosion. Solid products of corrosion Mechanism of corrosion of aluminum and various alloys. Passivation. The role of microstructure on corrosion.<br>*B: Forms of corrosion and related factors*<br>Uniform and localized corrosion. Galvanic corrosion. Pitting and crevice corrosion. Cavitation corrosion. Intergranular corrosion. Stress-corrosion cracking. Corrosion fatigue. Hydrogen embrittlement. Erosion corrosion. Atmospheric corrosion. Corrosion in concrete. Microbial corrosion. Corrosion of nanostructures. Corrosion in non-aqueous electrolytes. High-temperature corrosion.<br>Γ. *Corrosion protection and prevention*<br>Selection of materials resistant to corrosion. Active and passive corrosion protection methods. Cathodic and anodic protection, corrosion resistant coatings, corrosion inhibitors, passivators. Techno-economic criteria for selecting the most suitable method. Evaluation and performance monitoring of corrosion protection methods. Monitoring of corrosion in structures. Examples of corrosion failures. | | | |
| **Recommended literature** | 1. "Διάβρωση και προστασία υλικών", Π. Βασιλείου, Θ. Σκουλικίδης , Εκδ. Συμεών ( Ε. Καλαμαρά), Αθήνα ( 2007) ISBN 978-960-7888-85-3 | | | |
| | 2. "Principles of corrosion engineering and corrosion control, Zaki Ahmad, Elsevier Ltd, Oxford (2006), e-book, ISBN: 978-0-7506-5924-6 | | | |
| | 3. "Η διάβρωση και προστασία των μετάλλων με απλά λόγια" Α. Λεκάτου, Εκδ. Νημερτής (2013), ISBN 978-960-99591-2-4. | | | |
| **Teaching and learning methods** | **LECTURES** | **RECITATION** | **LAB/PRACTICE** | **PROJECT / HOMEWORK** |
| | 3 h/w | N h/w | 0 h/w | 0/semester |
| **Assessment type** | Combined | | | |
| **Assessment and grading methods** | - Final written exam<br>- Homework assignments, on volunteer basis.<br>- Laboratory projects (practice, reports)<br>The final mark is mainly based on the final written exam. Homework assignments and laboratory projects are taken into consideration (homework bonus). | | | |
| **Instruction Language** | Greek | | | |
| **Erasmus availability** | NO | | | |
| **Module URL** | https://eclass.upatras.gr/courses/CMNG2204/ | | | |
| **Last Amendment** | January 2017 | | | |

## Materials for Energy Applications

| **Module code** | **CHM_E_C6** | | | |
|---|---|---|---|---|
| **Module title** | ***Materials for energy applications*** | | | |
| **Status** | Live | **Type** | Elective | |
| **Category A** | Adv. Chem. Engineering (Breadth) | | **%** | 100% |
| **Category B** | Choose Module Category B | | **%** | % |

| | | | |
|---|---|---|---|
| **Module code** | **CHM_E_C6** | | |
| **Year of study** | 5 | **Semester** | Spring |
| **ECTS credits** | 3 | **Teaching Units** | 3. |
| **Name of lecturers** | Nikolaos Balis | | |

| **Learning outcomes** | **CAT** | **Description** |
|---|---|---|
| | D | The basic types of renewable energy sources and the main technologies for their utilization |
| | F | The fundamental properties and production methods for materials used in energy applications |
| | F | The main types of composite and nanocomposite materials used in energy saving applications and their main methods of production and mechanical properties |
| | D | The main photovoltaic technologies, the fundamental principles of solar modules operation and the design of photovoltaics plants |
| | D | The basic optical and thermal properties of materials used in passive and active thermal solar systems |
| | F | The main types of wind generators, the materials used for their construction and the energy production from wind plants |
| | D | The fundamental principles of steam engines, the materials used as engine components and their main properties and failure mechanisms. |

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

| **Teaching and learning methods** | **LECTURES** | **RECITATION** | **LAB/PRACTICE** | **PROJECT / HOMEWORK** |
|---|---|---|---|---|
| | 3 h/w | 0 h/w | 0 h/w | 1/semester |
| **Assessment type[9]** | Combined | | | |

| | |
|---|---|
| **Module code** | **CHM_E_C6** |
| **Assessment and grading methods** | 1. One project per group of one or two students in a specific Renewable Energy Systems topic (50 % of final grade). The students present their project and deliver a 10 pages summary of the project<br>2. Final written exams (50 % of final grade) |
| **Instruction Language** | Greek |
| **Erasmus availability** | YES |
| **Module URL** | https://eclass.upatras.gr/courses/CMNG2197/ |
| **Last Amendment** | December 2016 |

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