

Module Outline

1. GENERAL

SCHOOL	OF SCIENCE AND TECHNOLOGY		
PROGRAMME	Studies in Natural Sciences		
LEVEL OF STUDIES	Level 6 of the Hellenic and European Qualifications Framework		
MODULE CODE	FYE-22	YEAR	2 nd
MODULE TITLE	Physical Chemistry		
INDEPENDENT TEACHING ACTIVITIES <i>if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits</i>		HOURS	CREDITS
Weekly workload: (12-13 hours) x 32 weeks		392	14 ECTS
MODULE TYPE <i>Compulsory/Elective/ Mandatory Optional</i>	Compulsory		
MODULE DESCRIPTION <i>general background, special background, specialised, general knowledge, skills development</i>			
PREREQUISITE MODULES	FYE-12 General and Inorganic Chemistry		
LANGUAGE OF INSTRUCTION and EXAMINATIONS	Greek		
IS THE MODULE OFFERED TO ERASMUS STUDENTS	No		
MODULE WEBSITE (URL)	The Module has its own space in the digital learning environment of HOU (https://study.eap.gr/login/index.php) with controlled access (use of password) for students and Teaching Staff. The electronic Web page of the FYE-212 Module is the following: https://study.eap.gr/course/view.php?id=137		

2. LEARNING OUTCOMES

Learning outcomes

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

Consult Appendix A

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

LEARNING OUTCOMES

Knowledge:

Upon successful completion of the Module, students are expected to:

- acquire knowledge of basic concepts, principles, laws and applications of Physical Chemistry, with applications in the modern interdisciplinary professional and/or academic career of their choice
- understand adequately the fundamental principles of Chemical and Statistical Thermodynamics, Spectroscopy, Reaction Kinetics and Electrochemistry, to be in position to further enrich the depth and breadth of their knowledge in the pertinent fields.
- obtain the background that will enable them to acquire the skills and competences listed below
- acquire knowledge of the basic principles of Physical Chemistry and understand its role as a pillar of the interdisciplinarity of FYE.

Skills:

Upon successful completion of this Module, students will be able to:

- describe the definitions and fundamental concepts of the basic laws of thermodynamics
- define the basic thermodynamic functions, the chemical potential and the concept of the ideal gas.
- derive the ideal gas equation of state
- Describe the ideal gas mixture
- Describe the deviation of the gas behavior from ideality and give examples of real gas equations of states
- Define the reaction stoichiometry and describe the concept of the reaction progress
- Define the equilibrium constant, the reaction standard Gibbs free energy and the standard thermodynamic functions of compound formation
- Describe the temperature-dependence of the equilibrium constant and the effect of temperature and pressure conditions on the chemical reaction yield.
- Express the condition of phase equilibria in terms of the chemical potentials and qualitatively describe the temperature and pressure dependence of the chemical potential of a pure phase.
- Derive and write the Clausius-Clapeyron equation
- Draw the line boundaries between the three phases in a (p, T) diagram and describe the pertinent two- or three-phase equilibria.
- Define the ideal potential in terms of a chemical potential model
- Write Raoult's and Henry's Laws.
- Define the microstate and microstate of a system
- Define the statistical ensemble
- Calculate the statistical weight of a distribution and the partition function
- Calculate the thermodynamic functions of a system from the canonical partition function.
- Express and calculate the four contributions to the molecular partition function of a substance
- Describe the kinetic theory of gases and predict thermodynamic properties and transport properties of a perfect gas.
- Describe the basic characteristics of electromagnetic radiation

- Describe the basic principles of rotational spectroscopy, vibrational spectroscopy of diatomic molecules and of infrared and Raman spectroscopy
- Describe magnetic properties of nuclei comprising molecules and the basic concepts and principles of nuclear magnetic resonance (NMR) spectroscopy
- Define the basic concept of chemical kinetics, such as the reaction rate, the rate equation and the reaction order
- Apply the following methods for determining the rate equation: the differential method, the method of initial reaction rates, the isolation method, the integration method and the half-life method
- Write and apply the Arrhenius equation
- Describe the procedure of exploring the mechanism of a chemical reaction
- Describe the basic mechanisms of reversible, consecutive and parallel reactions as well as the pertinent methods their kinetic study
- Explain the terms electrochemical element, electrode, electrolyte, anode, cathode, half-reaction, electrolysis
- Describe the operation of an electrochemical cell and write the total reaction taking place
- Describe the various types of electrolytes
- Describe the behavior of ions in the presence of other ions due to mutual interactions
- Explain the ionic mobility in the interior of ionic conductors
- Describe the structure of the electrode-electrolyte interface
- Explain the conventions of the electrochemical cell representations and the sign of the electromotive force
- Predict the spontaneous direction of a redox system from measurements of electrode potentials
- Describe the state of electrochemical equilibrium for an interface and for an electrochemical reaction
- Explain the dependence of the equilibrium potential on the activities of the electroactive species
- Write the Nernst equation

Competences:

Upon successful completion of the module, students are expected to:

- develop critical thinking in applications of Physical Chemistry
- can conduct research, analysis and synthesis of data and information, for solving problems of Physical Chemistry by interpreting laboratory experimental measurements
- promote associations that lead to decision-making
- are able to conduct autonomous work involving chemistry
- are able to design experiments, undertake physicochemical experiments and draw conclusions through critical interpretation of experimental results

General Competences

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

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

Adapting to new situations

Decision-making

Working independently

Team work

Working in an international environment

Working in an interdisciplinary environment

Production of new research ideas

Project planning and management

Respect for difference and multiculturalism

Respect for the natural environment

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

Criticism and self-criticism

Production of free, creative and inductive thinking

The general skills that the students will acquire are:

- Search for, analysis and synthesis of data and information by the use of appropriate technologies
- Adaptation to new situations
- Decision-making

- Individual/Independent and autonomous work
- Respect for the natural environment
- Exercise of criticism and self-criticism
- Working in an interdisciplinary environment
- Development of free, creative, and inductive thinking

3. SYLLABUS

Purpose of Module

The main goal of this module is for the students to become familiar with the fundamental principles of Physical Chemistry, as well as with the pertinent applications in the different sectors of Natural Sciences.

Subjects covered

The subjects of the module include the following:

1. Chemical Thermodynamics
2. Statistical Thermodynamics
3. Spectroscopy
4. Chemical reaction kinetics
5. Electrochemistry

4. TEACHING and LEARNING METHODS - EVALUATION

DELIVERY <i>Face-to-face, Distance learning, etc.</i>	• Distance teaching and learning with five (5) Group Counseling Meetings (GCMs) of 4-hour duration each, during the academic semester on weekends. • Distance learning with six (5) Supportive Group Counseling Meetings (SGCMs) of 2 hour duration each, with emphasis and focus on methodology of problems and exercises solving. • Personal communication and feedback (advisory role of Adjunct Faculty members).
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY <i>Use of ICT in teaching, laboratory education, communication with students</i>	During GCMs, SGCMs, and teaching the following are used: • Remote meetings tools (Webex, Teams, Zoom), • Presentation software (PowerPoint, educational videos–animations, etc.), • Specialized software ((Chemical Drawing Software όπως ACD/ChemSketch, MedChem Designer, MarvinSketch - Create and Design, etc.), databases for the subjects under study (NCBI PubMed, Elsevier, etc.). In addition, students use office automation tools, text-editors, web browsers and e-reader for digital books. <u>Communication with the students is supported by:</u> • The digital platform of HOU (https://study.eap.gr/login/index.php) (course information, educational material posts, announcements, messages, examination results, user groups, discussion fora, etc.). • E-mail • Meetings through Zoom • Telephone consultations

TEACHING METHODS <i>The manner and methods of teaching are described in detail.</i> <i>Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.</i> <i>The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS</i>	<table border="1"> <thead> <tr> <th>Activity</th><th>Year Workload</th></tr> </thead> <tbody> <tr> <td>5 (GCMs) (x 4 hours each)</td><td>20</td></tr> <tr> <td>5 (SGCMs) (x 2hours each)</td><td>10</td></tr> <tr> <td>5 Written Reports (x 10 hours each)</td><td>50</td></tr> <tr> <td>Personal Study (9-10 hours x 32 weeks)</td><td>307</td></tr> <tr> <td>Exams (5hours)</td><td>5</td></tr> <tr> <td>Total Workload</td><td>392</td></tr> </tbody> </table>	Activity	Year Workload	5 (GCMs) (x 4 hours each)	20	5 (SGCMs) (x 2hours each)	10	5 Written Reports (x 10 hours each)	50	Personal Study (9-10 hours x 32 weeks)	307	Exams (5hours)	5	Total Workload	392
Activity	Year Workload														
5 (GCMs) (x 4 hours each)	20														
5 (SGCMs) (x 2hours each)	10														
5 Written Reports (x 10 hours each)	50														
Personal Study (9-10 hours x 32 weeks)	307														
Exams (5hours)	5														
Total Workload	392														
STUDENT PERFORMANCE EVALUATION <i>Description of the evaluation procedure</i> <i>Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other</i> <i>Specifically-defined evaluation criteria are given, and if and where they are accessible to students.</i>	Students' evaluation – Grade assessment of a Module: • Undertaking five (5) written assignments during the academic year. The average of the grades contributes to the formulation of the final grade of the module by 30%, if that grade allows further participation. • As a prerequisite to participation in the final exam, the cumulative grade of all five written assignments should be 25 (5x5=25) on a 0-10 scale for each written assignment. • The score of the written assignments (GE) is activated only with an average score equal to or above the base (≥ 5) in the final or make-up exams. • Final written exams, the grade of which contributes to the formulation of the final grade of the module by 70% (40% for the examination of Part 1 and 30% for the examination of Part 2). • The final grade of the module, on a 0 – 10 scale is calculated as follows $\text{Final Grade} = (\text{GE mean} \times 0,30) + (\text{Grade exam Part 1} \times 0,40) + (\text{Grade exam Part 2} \times 0,30)$ • All evaluation criteria are posted on the course website https://www.eap.gr/el/programmata-spoudwn/177-spoudes-stis-fysikes-epistimes/diarthrwnsi/403-4fc8fd8087500c236e505bdcc5e793bf Language of evaluation: Greek Part 1 may be examined on February, June or July, while Part 2 may be examined on June or July. Students can retake exams during the year for improving their grade.														

5. ATTACHED BIBLIOGRAPHY

• Suggested Bibliography Publications of the Hellenic Open University: Volume A: Chemical Thermodynamics, Hellenic Open University, Patras 2008. Volume B : Chemical Kinetics Part A, Hellenic Open University, Patras 2008. Volume B : Chemical Kinetics Part B, Hellenic Open University, Patras 2008. Volume C: Electrochemistry, Hellenic Open University, Patras 2008.

Volume D: Statistical Thermodynamics, Hellenic Open University, Patras, 2001
Volume E: Spectroscopy, Hellenic Open University, Patras 2001.

Additional supplementary digital material (and multimedia) is available within the study platform (study).

- **Related Scientific Journals**

1. Journal of Physical Chemistry, A, B & C (American Chemical Society)
2. Physical Chemistry Chemical Physics (Royal Society of Chemistry)
3. ChemPhysChem (Wiley)