

COURSE OUTLINE

(1) GENERAL

SCHOOL	SCHOOL OF SCIENCES		
DEPARTMENT	DEPARTMENT OF CHEMISTRY		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	YN605	SEMESTER	6 th Semester
COURSE TITLE	Physical Chemistry III		
TEACHING ACTIVITIES <i>If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.</i>	TEACHING HOURS PER WEEK	ECTS CREDITS	
	3 theory	5	
<i>Please, add lines if necessary. Teaching methods and organization of the course are described in section 4.</i>			
COURSE TYPE <i>Background, General Knowledge, Scientific Area, Skill Development</i>	General Background		
PREREQUISITES:			
TEACHING & EXAMINATION LANGUAGE:	Greek		
COURSE OFFERED TO ERASMUS STUDENTS:	NO		
COURSE URL:	https://eclass2.emt.duth.gr/courses/CHEM_H104/		

(2) LEARNING OUTCOMES

Learning Outcomes <i>Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.</i>																		
<p>Upon completion of the course, students will:</p> <ul style="list-style-type: none"> Understand capillary phenomena, types of interfaces, and their perspectives Be familiar with microscopy and spectrometry methods Be familiar with methods for the characterization and identification of inorganic nanoparticles Understand how interfacial properties differentiate Understand the adsorption of gases on solids Understand technological and other applications of Surface Physical Chemistry Understand the conductivity mechanism in conductive polymers and the principles of their basic applications 																		
<p>General Skills <i>Name the desirable general skills upon successful completion of the module</i></p> <table style="width: 100%; border: none;"> <tr> <td style="width: 50%; border: none;"><i>Search, analysis and synthesis of data and information,</i></td> <td style="width: 50%; border: none;"><i>Project design and management</i></td> </tr> <tr> <td style="border: none;"><i>ICT Use</i></td> <td style="border: none;"><i>Equity and Inclusion</i></td> </tr> <tr> <td style="border: none;"><i>Adaptation to new situations</i></td> <td style="border: none;"><i>Respect for the natural environment</i></td> </tr> <tr> <td style="border: none;"><i>Decision making</i></td> <td style="border: none;"><i>Sustainability</i></td> </tr> <tr> <td style="border: none;"><i>Autonomous work</i></td> <td style="border: none;"><i>Demonstration of social, professional and moral responsibility and sensitivity to gender issues</i></td> </tr> <tr> <td style="border: none;"><i>Teamwork</i></td> <td style="border: none;"><i>Critical thinking</i></td> </tr> <tr> <td style="border: none;"><i>Working in an international environment</i></td> <td style="border: none;"><i>Promoting free, creative and inductive reasoning</i></td> </tr> <tr> <td style="border: none;"><i>Working in an interdisciplinary environment</i></td> <td style="border: none;"></td> </tr> <tr> <td style="border: none;"><i>Production of new research ideas</i></td> <td style="border: none;"></td> </tr> </table>	<i>Search, analysis and synthesis of data and information,</i>	<i>Project design and management</i>	<i>ICT Use</i>	<i>Equity and Inclusion</i>	<i>Adaptation to new situations</i>	<i>Respect for the natural environment</i>	<i>Decision making</i>	<i>Sustainability</i>	<i>Autonomous work</i>	<i>Demonstration of social, professional and moral responsibility and sensitivity to gender issues</i>	<i>Teamwork</i>	<i>Critical thinking</i>	<i>Working in an international environment</i>	<i>Promoting free, creative and inductive reasoning</i>	<i>Working in an interdisciplinary environment</i>		<i>Production of new research ideas</i>	
<i>Search, analysis and synthesis of data and information,</i>	<i>Project design and management</i>																	
<i>ICT Use</i>	<i>Equity and Inclusion</i>																	
<i>Adaptation to new situations</i>	<i>Respect for the natural environment</i>																	
<i>Decision making</i>	<i>Sustainability</i>																	
<i>Autonomous work</i>	<i>Demonstration of social, professional and moral responsibility and sensitivity to gender issues</i>																	
<i>Teamwork</i>	<i>Critical thinking</i>																	
<i>Working in an international environment</i>	<i>Promoting free, creative and inductive reasoning</i>																	
<i>Working in an interdisciplinary environment</i>																		
<i>Production of new research ideas</i>																		

Search for, analysis and synthesis of data and information
Adapting to new situation
Decision-making
Autonomous work
Teamwork
Working in an international environment
Working in an interdisciplinary environment
Production of new research ideas
Project planning and management
Respect for the natural environment
Criticism and self-criticism
Promotion of free, creative and inductive thinking

(3) COURSE CONTENT

THEORY

1. **Principles of Quantum Mechanics.** Electromagnetic radiation, blackbody radiation, photoelectric effect, Compton effect, Bohr theory, wave-particle duality of matter. Schrödinger equation. The Born interpretation of the wavefunction.
2. **Techniques and Applications of Quantum Theory.** Transportation motion. Vibrational motion. Rotational motion.
3. **Atomic Structure and Atomic Spectra.** Structure and spectra of hydrogenic atoms. Structure of polyelectronic atoms. Slater determinant. Pauli exclusion principle. Spectra of complex atoms.
4. **Introduction to Molecular Quantum Chemistry.** The Born-Oppenheimer approximation. Valence-bond theory. Molecular orbital theory. Molecular orbitals for polyatomic systems.
5. **Molecular Symmetry.** Elements of group theory. Applications of symmetry in molecular orbital theory – Polyatomic molecules. Localized molecular orbital theory. Hybridization. Computational techniques in Quantum Chemistry. The Hückel approximation and prediction of molecular properties.
6. **Statistical Thermodynamics.** The distribution of molecular states. Internal energy and entropy. The canonical partition function. Independent molecules.
7. **Applications of Statistical Thermodynamics.** Average energies, heat capacities, equilibrium constants. Statistical properties of Macromolecules – Colloids.
8. **Molecular Interactions.** Electric properties of molecules. Polarizability. Polarization. Intermolecular interactions. Molecular interactions in gases. The liquid-vapor interface. Surface films. Condensation.
9. **Molecular Motion in Gases.** Molecular motion in liquids. Diffusion.
10. **Chemical Reaction Rates.** Experimental rate law. Reaction order and integrated rate laws. Temperature dependence and the Arrhenius equation. Determination of reaction mechanism from the rate law. Elementary reactions. Consecutive reactions. Examples of reaction mechanisms. Photochemistry.
11. **Reaction Dynamics.** Reactive encounters. Collision theory. Transition state theory.

LABORATORY

1. Langmuir-Blodgett Film Deposition Method (LB).
2. Determination of surface tension of solutions – Wilhelmy plate method.
3. Determination of interfacial tension – Spinning drop method (for liquid-liquid interfacial tensions).
4. Determination of contact angle during liquid-solid-gas interface interaction (Contact Angle Analyzer [CA]).
5. Material microstructure characterization methods I: Mercury Porosimetry (Mercury Porosimeter).
6. Material microstructure characterization methods II: Nitrogen Porosimetry – BET method (Nitrogen Porosimeter).

7. Atomic Force Microscopy (Atomic Force Microscope [AFM]).
8. Scanning Electron Microscopy: Familiarization with the operation of the electron microscope and X-ray analyzer (Scanning Electron Microscope with EDS (X-ray spectrometry) [SEM-EDX]).

(4) LEARNING & TEACHING METHODS - EVALUATION

<p style="text-align: center;">TEACHING METHOD <i>Face to face, Distance learning, etc.</i></p>	<p>Lectures on the board Face-to-face tutorials and laboratory exercises</p>	
<p style="text-align: center;">USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) <i>Use of ICT in Teaching, in Laboratory Education, in Communication with students</i></p>	<p>THEORY Use of ICT (Power point) in Teaching More than 200 multiple-choice questions using the click questions method (based on the MIT model). LABORATORY Use of ICT (PowerPoint and video) in teaching. Support for the learning process through the e-class electronic platform. Specifically, the slides from the tutorials, the theory and experimental instructions are posted, the pre-lab test is conducted, and the lab reports are submitted. Communication with students via email, answering questions.</p>	
<p style="text-align: center;">TEACHING ORGANIZATION <i>The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research & analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc.</i></p> <p><i>The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards.</i></p>	<p style="text-align: center;">Activity</p>	<p style="text-align: center;">Workload/semester</p>
	Lectures and problems (4 hours x 13 weeks)	91
	Laboratory exercises (3 hours per week x 13 weeks)	
	Final exam (3 hours)	3
	Student study hours, preparation for progress and final exam	81
	Total Course Hours 25 hours per credit	175 Total workload
<p style="text-align: center;">STUDENT EVALUATION <i>Description of the evaluation process</i></p> <p><i>Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others</i></p> <p><i>Please indicate all relevant information about the course assessment and how students are informed</i></p>	<p>Student evaluation methods Written final exam on Theory Minimum passing grade: 5 The lab grade is determined by the following: i. Careful and successful execution of experiments—Lab participation, grade A1, 5% ii. The lab notebook, which includes the presentation and evaluation of the experimental results and questions to reinforce the material, grade A2, 25% iii. The midterm written exam on the material covered in the laboratory exercises (progress), grade B1, 35% iv. The final written exam on the material covered in the laboratory exercises, grade B2, 35% The final overall grade for the course "Physical Chemistry Laboratory I" is calculated as follows: Final grade = {A1}x0.05 + {A2}x0.25 + {B1}x0.35 + {B2}x0.35 At the end of each semester, there is a week of make-up laboratory exercises. Students who have been absent once (1) during the current semester are eligible to participate. If a student has more than one absence, they must repeat the missed laboratory experiments in the following academic year. Students who have been absent from more than four laboratory exercises (≥4) must re-register for the course in a future semester and repeat all experiments.</p>	

	<p>Successful completion of all laboratory experiments is a prerequisite for students to take the final written exam.</p> <p>☒ If a student has completed the laboratory part of the exercises but has a laboratory grade lower than 5, they are given the opportunity to participate in a partial laboratory exam in September.</p> <p>The final overall grade for the course is calculated as follows: Final grade = {Theory}x0.60 + {Laboratory}x0.40</p>
--	---

(5) SUGGESTED BIBLIOGRAPHY

- Προτεινόμενη Βιβλιογραφία:

1. P. Atkins, J. De Paula, Φυσικοχημεία, Πανεπιστημιακές εκδόσεις Κρήτης (2015).
2. D.A. McQuarrie, Quantum Chemistry, Univ. Sci. Books (1983).
3. C.J. Cramer, Computational Chemistry, Wiley (2004).
4. Δ. Α. Γιαννακουδάκη, Μαθήματα Θερμοδυναμικής και Φ. Χημείας, Θεσ/νικη (1975).
5. Ν. Κατσάνος, Φυσικοχημεία: βασική θεώρηση, εκδόσεις Παπαζήση (1998).
6. W.J. Moore, Physical Chemistry, Longmans 4th ed. London (1962).
7. I.N. Levine Physical Chemistry, 6th ed., Mc Graw Hill, New York (2009).
8. L.C. Labowitz, J.S. Arents, Problems in Physical Chemistry Khosla Pub. (1995).
9. David R. Lide, CRC Handbook of Chemistry and Physics, 84th Ed., 2003-2004
10. Α. Γιαννακουδάκης, Μ. Σιγάλας, Π.Γιαννακουδάκης, Υβριδικές Εργαστηριακές Ασκήσεις σε θέματα Φυσικής Χημείας, Εκδόσεις Τζιόλα

- Συναφή επιστημονικά περιοδικά:

1. Journal of Chemical Education
The Physics Teacher