COURSE OUTLINE

(1) GENERAL

SCHOOL	ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MINERAL RESOURCES ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	MRE203	SEMESTER	2
COURSE TITLE	BASIC PRINCIPLES OF CHEMISTRY		

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	WEEKLY TEACHING HOURS	CREDITS
Lectures	3	4
Labs	1	1
Total	4	5
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Required, *general background*
PREREQUISITE COURSES:	There are no prerequisite courses
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	No
COURSE WEBSITE (URL)	https://eclass.uowm.gr/modules/document/?course=MRE121

(2) LEARNING OUTCOMES

Learning outcomes

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

Consult Appendix A

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

Students should be able to:

- develop a good sense of the effect of electronic structure on molecular geometry
- predict the geometry of a molecule according to the VSERP model
- understand the effect of atomic structure on the properties, selection and behavior of materials
- to correlate materials' properties with the type of molecular bonding
- to correlate the physical state of matter with the type of intermolecular forces
- to comprehend the theory of matter and its verification with experimental data
- handle basic laboratory techniques in chemistry
- describe the structure of shells and subshells in multi-electron atoms, and

relate them to the observed emission spectra
- correlate chemical activity with the number of electrons in the valence shell
- comprehend the necessity for the transition from the deterministic to the stochastic model of a group of atoms for explanation of the experimental data
- appreciate the concepts of equilibrium constant and solubility product
- appreciate the interdisciplinary nature of Electrochemistry
- comprehend the concepts of oxidation and reduction
- calculate open circuit voltages of electrochemical reactions of metals and predict their spontaneous direction
- understand the meanings anode and cathode in a fuel or electrolysis electrochemical cell and a battery
- appreciate the effect of composition and molecular geometry on the properties of a product
- explain the behavior of ionic substances in aqueous solutions

General Competences

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

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

Search for, analysis and synthesis of data and information, with the use of the necessary technology
Working independently
Team work
Working in an interdisciplinary environment
Criticism and self-criticism
Production of new Research ideas
Production of free, creative and inductive thinking
Showing social, professional and ethical responsibility

(3) SYLLABUS

INTRODUCTION- CLASSIFICATION- NOMENCLATURE- DEFINITIONS- CHEMICAL PRINCIPLES- ATOM-DEMOCRITUS- ELEMENTS-PERIODIC TABLE OF ELEMENTS- ATOMIC MODELS:
The Dalton atomic Model, Filling of the Periodic Table of Elements, Principles of Modern Chemistry, Laws of periodicity of Mendeleyev, Nuclear Reactions, Atomic structure, Ions, Isotopes, Avogadro and Faraday Numbers, Millikan experiment, Kroll reaction
Laboratory: Volumetric techniques
Atomic models of Rutherford & Bohr, Thomson model, Rutherford- Geiger- Marsden experiment, Bohr's postulates for the hydrogen atom, Planck-Einstein relationship, Bohr electron energy, matter/energy interactions involving atomic hydrogen, atomic

emission spectra: Angstrom experiment, electron orbital transitions, Balmer series, electromagnetic radiation, Spectroscopy, Solution of Bohr's equations, energy of ionization, Cathode-ray tube, atomic spectra and chemical analysis of the stars.
Laboratory: electronic balance
ELECTRON SHELLS- QUANTUM NUMBERS: Franck- Hertz experiment, Michelson-Morley experiment, Zeeman- Lorentz experiment, Stark experiment, Bohr' model modification by Sommerfeld, Stern- Gerlach experiment, electron spin, air ships of hydrogen and Helium
Laboratory: Filtration
PARTICLE-WAVE DUALITY: electron orbital filling in periodic table: Aufbau principle, Pauli exclusion principle, and Hund's rule, X-Ray diffraction, quantum mechanics: wave/particle duality, Davisson & Germer experiment, Heisenberg uncertainty principle, stochastic models for groups of atoms, Schrödinger equation, wave functions, atomic orbitals
Laboratory: Volumetric analysis (Titration)
PHOTOELECTRON SPECTROSCOPY: electronic structure- properties correlation, measurement of ionization energy, XPS technique, UPS and PES techniques, chemical activity and valence shell occupancy, average valence electron energy, Metals and non-metals, metalloids, semimetals, noble gases, element activity, octet stability by electron transfer, ionic bond, ionic compounds, electrometallurgy, electrolysis
Laboratory: Buffer solution and pH measurement
Ionic crystals, Born-Haber cycle: Properties of ionic crystals, ionic bonding: octet stability by electron sharing, crystal structure, Madelung constant, stability of ionic bond, energy of ion pairs vs. ion lattice, enthalpy of reaction: Hess's law, 1^{st} law of thermodynamics, ionic radii, industrial aluminum production, Born-Haber cycle for NaCl.
Laboratory: Electrolyte solutions
LEWIS STRUCTURES: Covalent bond = electron sharing (directional), mixed atomic orbitals, hybrid orbital, Pauling electronegativity, methane 3-D molecular structure, polar bond, polar molecule, covalent bond energy, supercapacitors and electrical energy storage, the CFC molecule.
Laboratory: Thin layer Chromatography
Hybridized & Molecular Orbitals: polar bonds, linear superposition, linear combination of atomic orbitals–molecular orbitals (LCAO-MO): energy level diagrams, bonding and anti-bonding orbitals, and hybridization, paramagnetism and diamagnetism, Aufbau principle for molecular orbitals, double and triple bonds, σ and π orbitals, hybridization, ionic conductivity of Cu-Au alloy.
Laboratory: Chromatographic techniques
THE SHAPES OF MOLECULES: Electron distribution in σ and π orbitals, hybridized orbital, Hybridized bonding in molecules, ethylene and acetylene, valence shell electron pair repulsion (VSEPR) theory, shapes of molecules and ions using hybridized orbitals, linear combination of atomic orbitals–molecular orbitals (LCAO-MO), and valence shell electron pair repulsion (VSEPR) theory, bonding and nonbonding electrons, bond energy, properties and type of bonding, graphite and diamond.

Laboratory: Chromatographic techniques 2, Thin layer Chromatography-2 and Column Chromatography

INTERMOLECULAR FORCES: Secondary bonding and state of matter, permanent and induced dipoles (London dispersion/van der Waals), hydrogen bonding, polarizability of molecules, effect of molecular geometry, effect of molecular volume on London dispersion forces, correlation of relative strengths of ionic, covalent, and various intermolecular bonds with bulk material properties in presence or absence of secondary bonds, bond length, biochemical phenomena.

Laboratory: Melting point measurement

Aqueous solutions, solid solutions and solid electrolytes, alloys, dispersion systems, solubility and solution enthalpy, saturated solutions, solubility of ionic compounds in water, solution conductivity, Arrhenius theory of electrolytic dissociation, solubility product, common ion effect, introduction to crystal systems, bulk metallic glasses

Laboratory: The Zn-Cu voltaic cell

Acids and bases, Arrhenius, Brønsted-Lowry, and Lewis models of acids and bases, acid strength, pH, acid-base reaction, conjugate acid-base pairs, strong and weak acids, equilibrium constants of acids and bases, acid strength and molecular bond energy, acid rain and coal- powered power plants, SO2 scrubbers

Laboratory: The Zn-Cu voltaic cell-2

INTRODUCTION TO ELECTROCHEMISTRY: Electrochemical processes, oxidation number, Reduction-Oxidation reactions (Red-Ox), galvanic cells, standard reduction potentials, Spontaneous Red-Ox reactions, Reaction Free energy change, electrochemical equilibrium, Nernst equation, concentration cells, batteries, fuel cells, biological fuel cells, corrosion, cathodic protection, electrolytic cells, Faraday's laws.

Laboratory: The Cu-Mg galvanic cell

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face, Distance learning, Lectures, Lab demonstration, Tutorials
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	E-Class, electronic communication, video demonstrations, intermediate exams via e-Class tools
TEACHING METHODS *The manner and methods of teaching are described in detail.* *Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.* *The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS*	

Activity	*Semester workload*
Lectures	36
Lab	12
Tutorials	32
Self-study	20
Course total	***100***

STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	Final exam (60%, minimum required grade =4/10), Multiple choice intermediate exam (20%), Homework (20%)

(5) SUGGESTED BIBLIOGRAPHY

- Suggested bibliography:

1. Εισαγωγή στην ηλεκτροχημεία, Συγγραφείς: Κυρατζής Νικόλαος – Ευριπίδης, Κωδικό στον Εύδοξο: 11262, ISBN: 960-431-953-1 Εκδότης: Ζήτη Πελαγία & Σια Ι.Κ.Ε.

2. ΣΥΓΧΡΟΝΗ ΓΕΝΙΚΗ ΧΗΜΕΙΑ (10η Διεθνής Έκδοση), Συγγραφείς: Darrell Ebbing, Steven Gammon, Κωδικό στον Εύδοξο: 41964283, ISBN: 978-618-5061-02-9, Εκδότης: ΤΡΑΥΛΟΣ & ΣΙΑ ΟΕ

3. ΦΥΣΙΚΟΧΗΜΕΙΑ (μετάφραση της 9ης αμερικανικής έκδοσης), Συγγραφείς: ATKINS PETER - DE PAULA JULIO, Κωδικό στον Εύδοξο: 41954666, ISBN: 978-960-524-431-6, Εκδότης: ΙΔΡΥΜΑ ΤΕΧΝΟΛΟΓΙΑΣ & ΕΡΕΥΝΑΣ-ΠΑΝΕΠΙΣΤΗΜΙΑΚΕΣ ΕΚΔΟΣΕΙΣ ΚΡΗΤΗΣ

4. Φυσικοχημεία, Συγγραφείς: Κατσάνος Ν., Κωδικό στον Εύδοξο: 68390063, ISBN: 978-960-02-0448-3, Εκδότης: ΕΚΔΟΣΕΙΣ Α.ΠΑΠΑΖΗΣΗΣ ΜΟΝΟΠΡΟΣΩΠΗ ΙΔΙΩΤΙΚΗ ΚΕΦΑΛΑΙΟΥΧΙΚΗ ΕΤΑΙΡΕΙΑ

5.: Επιστήμη και Τεχνολογία Υλικών, 9η Έκδοση , Συγγραφείς: Callister William D., Κωδικό στον Εύδοξο: 50655973, ISBN: 978-960-418-556-6 , Εκδότης: ΕΚΔΟΣΕΙΣ Α. ΤΖΙΟΛΑ & ΥΙΟΙ Α.Ε.

6.: Chemistry , Συγγραφείς: Chang-Goldsby, Κωδικό στον Εύδοξο: 59367765, ISBN: 9781259254581 , Εκδότης: Εκδόσεις ΕΠΙΚΕΝΤΡΟ Α.Ε.

7.: General Chemistry: The Essential Concepts, Συγγραφείς: CHANG, Κωδικό στον Εύδοξο: 12588633, ISBN: 9781259060427, Εκδότης: Εκδόσεις ΕΠΙΚΕΝΤΡΟ Α.Ε

8. General Chemistry: Principles, Patterns, and Applications, Publisher: Saylor Academy, Year Published: 2012

9. Αναλυτική Χημεία, Αντωνίου Κ. Καλοκαιρινού, Ελληνικά Ακαδημαϊκά Ηλεκτρονικά Συγγράματα και Βοηθήματα, www.kallipos.gr, ISBN: 978-960-603-508-1, Copyright © ΣΕΑΒ, 2015

10. ΑΝΟΙΚΤΑ ακαδημαϊκά μαθήματα Πανεπιστημίου Πατρών, ΕΡΓΑΣΤΗΡΙΟ ΟΡΓΑΝΙΚΗΣ ΧΗΜΕΙΑΣ, , Διδάσκοντες: Κων/νος Τσιτσιλιάνης, Καθηγητής Ουρανία Κούλη, Ε.ΔΙ.Π., Μαρία Τσάμη, Ε.ΔΙ.Π., Πολυτεχνική Σχολή, Τμήμα Χημικών Μηχανικών

11. : http://physics.nist.gov/constants

12. Introduction to Solid State Chemistry,Instructor(s), Prof. Donald Sadoway, MIT Open Courseware

13. Καρκαλούσος, Π., Γεωργίου, Ζ., Κρούπης, Χ., Παπαϊωάννου, Ά., Πλαγεράς, Π., Σπυρόπουλος, Β., Τσότσου, Γ., Φούντζουλα, Χ. 2015. Υγρή χρωματογραφία υψηλής πίεσης (απόδοσης) στην κλινική χημεία. Βασικές αρχές και παραδείγματα.. [Κεφάλαιο Συγγράμματος]. Στο Καρκαλούσος, Π., Γεωργίου, Ζ., Κρούπης, Χ., Παπαϊωάννου, Ά., Πλαγεράς, Π., Σπυρόπουλος, Β., Τσότσου, Γ., Φούντζουλα, Χ. 2015. Εργαστηριακές ασκήσεις κλινικής χημείας. [ηλεκτρ. βιβλ.] Αθήνα:Σύνδεσμος Ελληνικών Ακαδημαϊκών Βιβλιοθηκών. κεφ 8. Διαθέσιμο στο: http://hdl.handle.net/11419/5388, Εκδόσεις Κάλλιπος

14. http://eclass.teiion.gr/modules/document/file.php/CULTURE205/%CE%94%CE%B9%CE%B1%CF%86%CE%AC%CE%BD%CE%B5%CE%B9%CE%B5%CF%82/6_%CE%A7%CF%81%CF%89%CE%BC%CE%B1%CF%84%CE%BF%CE%B3%CF%81%CE%B1%CF%86%CE%B9%CE%BA%CE%B5%CF%82%20%CE%BC%CE%B5%CE%B8%CE%BF%CE%B4%CE%BF%CE%B9%20%CE%B4%CE%B9%CE%B1%CF%87%CF%89%CF%81%CE%B9%CF%83%CE%BC%CE%BF%CF%85.pdf

- Related academic journals:

Journal of Chemical Education (https://pubs.acs.org/journal/jceda8)