UNIVERSITY OF CRETE

COURCE OUTLINE

DEPARTMENT OF

MATERIALS SCIENCE AND ENGINEERING

2025

ΠΕΡΙΕΧΟΜΕΝΑ

COURSES OUTLINE

FIRST SEMESTER

EMY - 101 Physics I: Classical Mechanics (Theory – Laboratory)

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	EMY-101	**SEMESTER**	1st
COURSE TITLE	PHYSICS I: CLASICAL MECHANICS (Theory – Laboratory)		
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		4	
Exercises		2	
Lab Experiments		2	
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		8	8
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	GENERAL BACKGROUND, SKILLS DEVELOPMENT		
PREREQUISITE COURSES:			
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES		
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy101/		

(2) LEARNING OUTCOMES

Learning outcomes

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

Consult Appendix A

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

- *Guidelines for writing Learning Outcomes*

By the end of the course, students are expected to:

1. Consolidate high school classical mechanics albeit at a higher mathematics level and on a phenomenological manner.
2. Acquire critical thinking and the ability to develop physical models and solve problems.
3. Get accustomed to the mathematical formulation of the laws of physics: for this purpose, calculus and very simple differential equations are used.
4. Acquire the relevant background and skills for understanding materials physics in the more advanced theoretical and laboratory courses that follow.
5. Are able to use, on a basic level, specialized measurement instruments such as laser, photogates and Computer Assisted Measurements. (skill)
6. Are able, starting from experimental data, to provide a report analysing and presenting the results. (competence)
7. Can assess the quality and the reliability of experimental data. (competence)

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

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…*
	…….

- Production of free, creative and inductive thinking
- Working independently, Adapting to new situations
- Collection, analysis, synthesis and assessment of data and information with the use of the necessary technological means. (measurement instruments, computer processing)
- Working as a team.
- Composition of reports presenting scientific data.

(3) SYLLABUS

Theory:

1. Physics in Materials Science, structure of matter and physical models, classical and modern Physics, Classical Mechanics
2. Introduction, fundamental and derived quantities, units, dimensional analysis, order-of-magnitude calculations, significant figures

3. Kinematics, motion in one dimension, position, displacement, average and instantaneous velocity, constant velocity motion, average and instantaneous acceleration, motion with constant acceleration, free fall, kinematic equations derived from calculus
4. Motion in three dimensions, position, velocity, acceleration vectors, motion in two dimensions with constant acceleration, projectile motion, curved orbit motion, tangential and radial acceleration, uniform circular motion, relative velocity and acceleration
5. The concept of force, Newton's 1st law and inertial frames, Newton's 2nd law, gravitational force and weight, Newton's 3rd law
6. Applications of Newton's laws, forces of friction, circular motion, motion in accelerated frames, motion in the presence of resistive forces
7. Energy of a system, work done by constant force, work of varying force, kinetic energy and the work-kinetic energy theorem, potential energy of a system, conservative and non-conservative forces, relationship between conservative forces and potential energy, energy diagrams and equilibrium of a system.
8. Isolated and non-isolated systems, conservation of energy, changes in mechanical energy for non-conservative forces, power
9. Linear momentum, isolated and non-isolated systems, momentum conservation, impulse of a force, impulse-momentum theorem, elastic and inelastic collision, perfectly inelastic (plastic) collision, collision in two dimensions, center of mass of a system of particles and of an extended object, physical significance and usefulness of the center of mass, deformable systems, rocket propulsion
10. Rotation of a rigid object about a fixed axis, angular position, velocity, acceleration, quantities of rotational and translational motion, rotational kinetic energy, calculation of moments of inertia, torque, relationship between torque and angular acceleration, energy in rotational motion, rolling motion of a rigid object
11. Angular momentum of a rotating particle and of a system of particles, non-isolated system, angular momentum of a rigid object, isolated system and angular momentum conservation
12. Static equilibrium and elasticity, elastic properties of solids
13. Oscillatory motion, harmonic oscillator, damped and forced oscillations

Lab:

Educational quantitative experiments on simple physics phenomena.

1. Introduction on processing of measurements and report writing.
2. Linear motion
3. Rotational motion,
4. Oscillations
5. Circular motion,
6. Simple and compound pendulum.

The students perform verificatory experiments for basic laws of physics: Newtons laws of motion, Hook's law on elasticity.

In the experiments are used basic and more specialized instruments and techniques for the measurements of physical quantities. Stopwatch, Vernier Caliper, Micrometer Caliper, laser, photogate, computer assisted measurements.,

The experimental process is followed by basic data processing and analysis: average value, standard deviation, linear least square regression, error in measured and calculated quantities.

(4) TEACHING and LEARNING METHODS - EVALUATION

<table>
<tr><td>DELIVERY
Face-to-face, Distance learning, etc.</td><td>Face-to-face</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
Use of ICT in teaching, laboratory education, communication with students</td><td>Use of ICT for communication with students who are encouraged to search for online material for better understanding material taught in class. The use of computers in data processing and presentation is strongly recommended, encouraged, and facilitated. Basic methods of computer aided measurements are introduced.</td></tr>
<tr><td>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</td><td>
<table>
<tr><th>Activity</th><th>Semester workload</th></tr>
<tr><td>Lectures</td><td>52</td></tr>
<tr><td>Exercises</td><td>26</td></tr>
<tr><td>Study hours</td><td>80</td></tr>
<tr><td>Lab Intro</td><td>2x2</td></tr>
<tr><td>Lab Experiments</td><td>6x2</td></tr>
<tr><td>Reports</td><td>6x6</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Course total</td><td>200</td></tr>
</table>
</td></tr>
<tr><td>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.</td><td>Student performance evaluation regarding theory lectures consists of an optional midterm exam and a mandatory final exam in Greek that includes multiple choice questions and problems.
The assessment of students regarding the lab experiments is performed in Greek language, in 3 steps.

Step 1. Brief asynchronous online examination regarding the theoretical basis of each experiment. Brief oral questions regarding the experimental setup.
Criteria: Description of the physical phenomenon, knowledge of the laws of physics involved, basic understanding of the experimental procedure (what is measured and how)

Step 2: Evaluation of the report submitted by the students on the experimental procedure. The grade is the same for all members of the same group.
Criteria; Measurement process and analysis, Plots, Presentation of results, judgment of the plausibility of results, overall appearance of report.

Step 3: Written exam at the end of the semester where students are asked to process and present given experimental data.
Criteria: Ability to apply the methods used during the semester, correct graphic representation of results, and calculation of physical quantities, on provided measurements.

Students have the right to view their exam scripts after the grading results and to ask questions.</td></tr>
</table>

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- R.A. Serway, J.W. Jewett, Jr., Physics for Scientists and Engineers, Mechanics, Oscillations and Mechanical Waves, Thermodynamics, Relativity, 8th edition, Greek translation Kleidarithmos Editions, Athens (2012).
- H.D. Young, R.A. Freedman, University Physics with Modern Physics, Greek translation, Volume A', Mechanics-Waves, 11th edition, Greek translation, 2nd Greek edition, Papazisi Editions, Athens (2009).
- P.G. Hewitt, Conceptual Physics, 9th American edition, Greek translation, Crete University Press, Heraklion (2011).
- H.C. Ohanian, Physics, Norton, London, (1985), Greek translation, Symmetria Editions, Athens (1991)].
- C. Kittel, W.D. Knight, M.A. Ruderman, Mechanics: Berkeley Physics Course, Volume I, Symmetria Editions, Athens (1978).
- R.P. Feynman, R.B. Leighton, M. Sands, The Feynman Lectures on Physics, Volume I, Addison-Wesley (1963).
- Ανδρέας Ζέζας, Σημειώσεις Εργαστηρίων Φυσικής Ι: Μηχανική και Θερμοδυναμική, Τμήμα Φυσικής Πανεπιστήμιο Κρήτης, 2013.
- Χρ. Χαλδούπης, Εργαστηριακές Ασκήσεις Φυσικής: Μηχανική - Θερμότητα, Πανεπιστήμιο Κρήτης, Ηράκλειο (1996).

EMY - 111 Mathematics I

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**EMY-111**	**SEMESTER**	**1st**
COURSE TITLE	MATHEMATICS I		
INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*		**WEEKLY TEACHING HOURS**	**CREDITS**
		6	6
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).			
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	GENERAL BACKGROUND		
PREREQUISITE COURSES:	-		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES		
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy111/		

(2) LEARNING OUTCOMES

Learning outcomes
The learning goals that students should have achieved at the end of the lesson are the following: • Calculation of derivatives and limits of functions, determination of the stationary points and the use of this information to sketch curves. • Calculation of indefinite and definite integrals. • Find the Taylor series of simple functions and use them to approximate values of functions. • Perform basic operations with complex numbers. • Use of derivatives and integrals to solve problems arising in physical sciences and engineering. • Find the partials derivatives of functions of many variables and sketch the contour lines. *The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.*
General Competences
The course is formed in such a way, that during lectures and especially during the preparation of the written assignment (homework), that students will train themselves in: • Working independently on solving problems • Critical thinking • Interdisciplinary knowledge

(3) SYLLABUS

1. Elementary functions (exponential, trigonometric, hyperbolic, logarithmic, inverse). Trigonometric identities. Plane polar coordinates.
2. Limits. Properties. Continuity of a function. Asymptotes. L' Hôpital rules.
3. Derivatives. Chain rule. Derivative of basic, inverse and implicit functions. Higher order derivatives. Stationary points. Graphic representation of a function.
4. Complex numbers. Basic operations. Polar form. Complex conjugate. Multiplication and division using the polar form. Roots. Exponential form. De Moivre theorem.
5. Functions of many variables. Surfaces. Contour lines. Partial differentiation. Change of variables. Chain rule of partial differentiation.
6. Power series and polynomials. Taylor and MacLaurin series. Binomial theorem.
7. Integrals. Indefinite. Area under a curve. Definite integrals and their properties. Integrals of basic functions.
8. Methods of integration (recognizing the presence of a function and its derivative, odd and even powers of sinx, cosx, change of variable, integration by parts, reduction formulae). Applications: Mean value. Length of curves. Moments and center of mass. Surface area and volume of a solid by revolution. Double integrals. Variable limits. Triple integrals.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY	Face-to-Face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY	Supportive learning through the active web site of the course in the learning platform of the University of Crete (teleclass.uoc.gr).
TEACHING METHODS	

Activity	***Semester workload***
Lectures	52
Classwork	26
Homework	102
Course total	***180***

STUDENT PERFORMANCE EVALUATION	Students are evaluated by: 1. Series of optional tests 2. Final exam

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

1. *J. Hass, C. Heil, M. Weir, Thomas , Infinitesimal Calculus, PEK, 2018.*
2. *T. Rasias, Mathematics I, Tsotras Publishing,2017.*
3. Wrede Robert C.,Spiegel Murray R. , Advanced Mathematics, Tziola Publishing, 2015.

EMY - 121 General Chemistry (Theory – Laboratory)

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING			
ACADEMIC UNIT	MATERIALS SCIENCE AND ENGINEERING			
LEVEL OF STUDIES	UNDERGRADUATE			
COURSE CODE	**EMY-121**	**SEMESTER**	**1st**	
COURSE TITLE	General Chemistry (Theory – Laboratory)			
INDEPENDENT TEACHING ACTIVITIES			**WEEKLY TEACHING HOURS**	**CREDITS**
			8	8
COURSE TYPE	GENERAL BACKGROUND			
PREREQUISITE COURSES:	-			
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK			
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES			
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy121/			

(2) LEARNING OUTCOMES

Learning outcomes
• Η ύλη του μαθήματος αποτελεί μια γενική εισαγωγή στις βασικές χημικές έννοιες. Στόχος του μαθήματος είναι η κατάρτιση των πρωτοετών φοιτητών στα γνωστικά αντικείμενα που θεραπεύονται από το τμήμα και άπτονται στην επιστήμη της Χημείας. Οι μαθησιακοί στόχοι τους οποίους οι φοιτητές στο τέλος του μαθήματος θα πρέπει να έχουν επιτύχει είναι οι εξής: 1. Basic Chemistry knowledge

2. Atomic and molecular structure of Matter
3. States of Matter and Solutions
4. Chemical Reactions and Chemical equilibria

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

-Development of critical thinking
-Promotion of free, creative and inductive thinking
Students at the end of the experimental part of the course are expected to:
1. Familiarize themselves with the conditions of conducting a laboratory course as well as with the rules of operation and the safety rules that govern a Laboratory course.
2. To know basic analytical techniques that are expected if they use in their professional life such as titration, infiltration, sinking, quality analysis, preparation of solutions of specific concentration and content, dilutions of solutions.
3. Be able to know the use of basic chemical utensils such as the pipette, the burette, the volumetric and conical flask, the volumetric cylinder as well as the use of certain devices such as the analytical scale, the drying oven, the UV lamp etc.
4. Be prepared to attend more demanding laboratory courses such as the teaching of the next laboratory courses of the Department.

(3) SYLLABUS

1. Basic Chemistry knowledge: Measuring units, Balancing of chemical reactions
2. Atomic and molecular structure of Matter: The structure of the atom, atomic orbitals, Periodic Table and the periodic properties of elements, Chemical bond and bond theories, Molecular geometry, Molecular orbitals
3. States of Matter and Solutions: Gas Phase, Ideal-gas equation, Kinetic Theory of Gases, Liquid phase, Intermolecular forces, Phase diagrams, Solid phase, Structure of Solids, Bonding in solids, Alloys, Metals-Semiconductors-Insulators, Polymers, Nanomaterials, Solution Properties, Colligative properties
4. Chemical Reactions and Chemical equilibria: Mechanism of chemical reactions, order of reaction, Chemical equilibrium, LeChatelier principle, Acid-base equilibrium, acid-base classification, common-ion effect, Soulbility

- Concerning the experimental part of the course students are expected to get familiar with basic Laboratory Techniques
- Chemical equilibrium - , Weak electrolyte ionizations (salt hydrolysis, buffer solutions, indicators)
- Water hardness determination-compexometric titration
- Photospectroscopy, redox titration
- Pehametric titration (equivalent point, determination of the constant of a weak acid)
- Qualitative analysis of cations of group 1
-

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY.	Face-to-Face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY	Use of Power Point

TEACHING METHODS	***Activity***	***Semester workload***
	Lectures	52
	Laboratory	26
	Worked-out examples	26
	Homework	96
	Course total	**200**
STUDENT PERFORMANCE EVALUATION	The student performance will be evaluated by two mid-term exams and a final exam at the end of the semester. The final grade will be the summation of the two mid-term exams' grade (30% each) and the final exam grade (40%) under the clause that the grade will be higher than 5 (out of 10) in the final exam.	

(5) ATTACHED BIBLIOGRAPHY

1. T. L. Brown, H. E. Lemay, B. E Bursten, C. J. Murphy, P. M. Woodward, M. W. Stoltzfus «Chemistry, Central Science», 13η edition, Ziti publications 2016
2. D. D. Ebbing, S. D. Gammon «General Chemistry» 10η edition, Travlos publications 2014
3. P. Atkins, L. Jones, L. Laverman «Chemistry Principles» 1st edition, Utopia publications 2018
4. M. Vamvakaki, Handbook of General Chemistry Laboratory, University of Crete, Heraklion, (2003).
5. J. H. Nelson, K. C. Kemp, Lab Experiments, Prentice Hall (2000).
6. L. Peck, K. J. Irgolic, Measurement and Synthesis in the Chemistry Laboratory, Prentice Hall (1998).
7. G. M. Bodner, H. L. Pardue, Chemistry : An Experimental Science, John Wiley & Sons (1994).
8. J. H. Nelson, K. C. Kemp, B. L. Bursten, Chemistry : The Central Science : Laboratory Experiments, Prentice Hall College Division (1996).
9. S. L. Murov, B. Stedjee, Experiments in Basic Chemistry, 4th Edition, John Wiley & Sons (1996).
10. R. A. D. Wentworth, Experiments in General Chemistry, Houghton Mifflin College (1999).
11. S. L. Murov, Experiments in General Chemistry : Laboratory Manual to Accompany Umland/Bellama's General Chemistry, Brooks/Cole Pub Co. (1998).

EMY - 141 Introduction to Materials Science

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING			
ACADEMIC UNIT	MATERIALS SCIENCE AND ENGINEERING			
LEVEL OF STUDIES	UNDERGRADUATE			
COURSE CODE	**EMY-141**	**SEMESTER**	**1st**	
COURSE TITLE	Introduction to Materials Science			
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	
Exercises			1	
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).			4	5
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	General background			

PREREQUISITE COURSES:	-
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy141/ https://teleclass.materials.uoc.gr/courses/SEM1108/

(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*

- Foundation of **knowledge** though an interdisciplinary approach that combines Physics, Chemistry and Mathematics for understanding the properties of materials.
- **Understanding** of the principles that correlate macroscopic properties of materials with different levels of material structure (atoms, bonds, crystal lattice)
- **Understanding** the basic principles of experimental methods for the analysis of the structure and composition of matter
- **Application** of realistic basic design strategies and materials selection schemes though realistic design problems of materials design

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

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…*
	…….

- Knowledge of the basic methods of materials characterization and understanding in quantitative and qualitative terms the results of such measurements.
- Can predict qualitatively and quantitatively, where possible, the macroscopic properties of materials based on their structure.
- Be able to describe qualitatively and quantitatively the basic requirements a material should satisfy for use in a realistic application.
- Can choose the most suitable material based on the specifications for applications involving mechanical, thermal or electrical properties or their combination

(3) SYLLABUS

1. **Introduction**
2. **Categories of Materials-Applications-Examples**
   Metals, Ceramics, Polymers, Composite Materials
3. **Atomic Structure**
   Structure and constituents of atoms, Fundamentals of Quantum Mechanics, Quantum mechanical description of atoms
4. **Bonds**
   Forces between atoms, Potential, Ionic bonds, *Ionization potential, Electron Affinity,* Covalent bonds, Metallic bonds, Secondary Bonds, *Wan der Waals bonds, Hydrogen bonds*
5. **Structure**
   Crystalline, amorphous materials, *Unit cell, Atomic Packing Factor (APF),* Metallic crystals, (FCC), (BCC), (HCP), Ionic solids, Covalent solids. Polymer structures, molecular configurations, co-polymers, polymer crystallinity. Crystal Lattice, *Crystal systems, Crystallographic directions, Crystallographic planes,* Structural analysis techniques, *X*-ray Diffraction (XRD)
6. **Phase diagrams and phase transformations**
   Solubility limit, Phases, unit phase diagrams, binary phase diagrams, eutectic systems. Phase transformations: kinetics and equilibrium. Iron-carbon alloys.
7. **Mechanical Properties**
   Deformation, Mechanical Stress, Elastic behavior, Plastic behavior, *Tensile strength, Ductility, Resilience, Toughness,* Hardness.
8. **Thermal Properties**
   Heat Capacity, *Phonons,* Thermal Expansion, Thermal conductivity, Thermal stress-resistance to thermal shock
9. **Electrical Properties**
   Ohm's law, electrical conductivity, Electrical properties at the atomic scale, *Energy bands, Fermi energy, Carrier mobility and conductivity,* Electrical properties of metals, Semiconductors, Ionic ceramics, Electrical properties of polymers, Conductive polymers

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face to face lectures

USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
Use of ICT in teaching, laboratory education, communication with students
	• Use of slides (powerpoint)
	• Videos with demonstration/understanding experiments.
	• Open and free educational material available through the eClass webpage (Creative Commons CC-BY-ND-3.0, licenses) of the following:
	  ○ Lecture slides
	  ○ Solved and unsolved exercises
	  ○ Simulations and animations with the use of open-source software
	  ○ Supplementary materials (slides) for further understanding
	  ○ Video-recorded lectures
	• Furthermore in the eClass webpage the students can find:
	  ○ Selected previous exams
	  ○ Useful links and examples
	  ○ Sets of self evaluation tests (quiz) with automated grading and comments
	  ○ Bibliography

<table>
<tr><td></td><td>

- Communication through email and constant office hours available through the class webpage.

The lectures are offered through the open courses of the University of Crete, (https://opencourses.uoc.gr/courses/course/view.php?id=216) where the students have access besides the abovementioned video lectures and exercises
</td></tr>
<tr><td>

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
</td><td>

Activity	***Semester workload***
Lectures	39
Exercises	13
Directed learning activity (office hours)	13
Non-directed learning activity	60
Course total	**125**

</td></tr>
<tr><td>

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.
</td><td>

Language: Greek
Final written exams (100%)

The evaluation criteria are accessible in the class webpage.
</td></tr>
</table>

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- W. D. Callister, *"Materials Science and Engineering"*, Willey (2001)
- Michael F. Ashby, Hugh Shercliff, David Cebon, *"Materials: Engineering, Science, Processing and Design"*, Butterworth-Heinemann, (2007)

- Related academic journals:

EMY - 011 English I

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING
LEVEL OF STUDIES	UNDERGRADUATE

COURSE CODE	**EMY-011**	**SEMESTER**	**1st**
COURSE TITLE	English I		
INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*		**WEEKLY TEACHING HOURS**	**CREDITS**
		3	3
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).			
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	GENERAL BACKGROUND & SKILLS DEVELOPMENT		
PREREQUISITE COURSES:	-		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	English		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES		
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy011/		

(2) LEARNING OUTCOMES

Learning outcomes
The learning goals that students are expected to attain are the following: 1. learn scientific terminology of Materials science 2. Improve academic skills pertaining to formality, caution, legitimate paraphrasing, writing citations and synthesising sources, critical writing, essay writing (with documented evidence), peer-feedback and academic presentations. *The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6 (comprehensive, specialised, factual and theoretical knowledge within a field of work or study and an awareness of the boundaries of that knowledge).*
General Competences
The course is formed in such a way, that during lectures and especially during the preparation of the written assignment (homework), that students will be able to: (1) Notice formality and academic style conventions, (2) Notice scientific conventions in Materials Science Journals (3) Transfer information form texts and visually enhance it in order to produce PowerPoint slides. (4) Write a laboratory report following a graph or chart, (5) Exercise peer-feedback (6) Give effective presentations. (7) Write citations and references.

(8) Synthesise sources, summarise and paraphrase academic sources legitimately.

(3) SYLLABUS

dents are introduced to Formality and academic style conventions. Students learn how to notice formality, citations and onventions and following a model text, produce their own based on reference and citation guides provided for guidance.

dents exercise reading skills like skimming and scanning on a reading about “Types of Materials” and learn how to transfer n from text to slides. Students also practice listening and a variety of note-taking skills on a topic similar to the reading. Students finally ving presentations using opening phrases and signposting language for academic presentations.

dents are expected to improve their collaborative skills by using google docs about different types of Metals and their Students will be reading an article on the FUTURE of metals in order to learn how to produce well-structured, coherent and cohesive as such they will be asked to identify topic sentences, support sentences and concluding sentences in paragraphs. Then, they e their own paragraph following prompts.

dents will learn how to present and analyse statistical data, graphs and charts and learn how to write a report using appropriate linking terminology to express upward or downward trends, ratios, averages and numbers. Students will using information to produce a variety mind-maps, diagrams, word tables or schemes.

dents are expected to improve their critical thinking skills by comparing different types of writing on the topic of “Bio-printing ey will be asked to notice the structure, the language and some conventions of a scientific article about Graphene, a relevant blog post he and a school textbook entry.

udents will be familiar with “How to give effective presentations” after a model presentation on “bio-printing” will be given by senior tudents are expected to practice peer-assessment skills using *criteria for peer-evaluation* and then discuss the student presentation nd weaknesses with the teacher and the presenters.

dents will classify and identify properties of *solids, liquids and gases* (using the English for Chemistry EAP textbook, Unit 1) Reading and sks.Students will be asked to notice and use legitimate paraphrasing strategies in order to produce a paragraph with citations and

dents will be listening and reading a variety of listening and reading sources about Ceramics and advanced Ceramics in order to include tion elements, reminder phrases and references required for Summary writing. Language focus Passive voice

dents will be introduced to essay writing (argumentative essay, counterarguments) making a distinction between descriptive, evaluative, nd biased language. Reading and Listening Practice on the topic of Composites.Students will be practicing answering mock exam reading sion questions and tasks.

llowing a listening and a reading on Polymers (from the book English for Chemistry EAP Unit 11) students will be asked to make a mind cting properties of of Polymers such as thermosetting, thermoplastic, linear, branched, cross-linked, fibers, plastics and elastomers, nd rigidity. Language focus: Gerund and infinitive Students will be re-writing sentences avoiding wordiness

nd 12 Student Presentations (Slides need to be in pptx or pdf format and student need to bring their file in a usb stick)

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY	Face-to-Face & Distance Learning (Asynchronous via Edmodo)
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY	Use of Power Point, and White board, Supportive learning through teleconference tools, Googledocs, google forms , Edmodo, Socrative, Kahoot googleslides, edpuzzle

TEACHING METHODS	***Activity*** ***Semester workload*** Workshops 30 hours Student presentations-Peer-feedback 6 hours Homework 44 **Course total** **80 hours**
STUDENT PERFORMANCE EVALUATION	Students are evaluated by: Coursework (Portfolio) and presentations 50% Written exam 50%

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

1. Katsampoxaki-Hodgetts K. (2017) English for Chemistry EAP, Disigma Publications

https://www.disigma.gr/english-for-chemistry-eap.html

- Related academic journals:
Suggested for presentations:

Please make sure you choose ONE article from the most downloaded articles section of the following journals:

a) https://www.journals.elsevier.com/journal-of-science-advanced-materials-and-devices/most-downloaded-articles

b) https://www.journals.elsevier.com/progress-in-materials-science/most-downloaded-articles

c) https://www.journals.elsevier.com/materials-today/most-cited-articles

d) https://www.journals.elsevier.com/materials-today-communications/most-downloaded-articles

e) https://www.journals.elsevier.com/biomaterials/most-downloaded-articles

f) https://www.journals.elsevier.com/energy-storage-materials/most-downloaded-articles

g) https://www.journals.elsevier.com/materials-characterization/most-downloaded-articles

SECOND SEMESTER

EMY - 102 Physics II: Electricity-Magnetism (Theory – Laboratory)

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	EMY-102	**SEMESTER**	**2nd**
COURSE TITLE	PHYSICS II: Electricity-Magnetism (Theory – Laboratory)		
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**
		8	8
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).			
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	GENERAL BACKGROUND		
PREREQUISITE COURSES:	-		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES		
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy102/		

(2) LEARNING OUTCOMES

Learning outcomes

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

Consult Appendix A

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

The course covers the physics of electricity and magnetism using mathematics on an advanced level compared to the corresponding requirements in secondary education. The course learning outcomes are:

- Understanding basic physics laws and concepts in the fields of electricity and magnetism
- Employing the acquired knowledge to analyze and solve respective physics problems with the use of calculus.
- Understanding of a physical problem related to Electromagnetism (especially one that needs an experimental approach) and finding the correct methodology necessary to answer a specific problem.
- Employing the acquired knowledge to analyze and solve respective physics problems with the use of calculus.
- To become familiar with the concepts of experimental measurements, absolute and relative experimental error, and their sources, and how to present results with meaningful significant digits.

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

¨΄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…*
	…….

- Production of free, creative and inductive thinking
- Search for, analysis and synthesis of data and information, with the use of the necessary technology.
- Team work

(3) SYLLABUS

- Theory
  - Electric field, Coulomb's law, Gauss law.
  - Electric potential
  - Capacitors, dielectrics, current and resistance.
  - DC circuits, magnetic fields
  - Sources of magnetic field, Biot-Savart law, Ampere's law.
  - Faraday's law, electromagnetic induction, solenoids
  - AC circuits
- Laboratory Exercises from Electricity and Magnetism
  - Construction and operation of DC electrical circuits, Ohm's law, Kirchhoff's rules, simple electrical measurements
  - Construction and operation of AC electrical circuits, RLC combination, using the Oscilloscope, study of resonance
  - Electrolytic dissociation and Faraday's laws in Copper Sulfate and dilute Sulfuric acid aqueous solutions.
  - Ampere's law and magnetic field in solenoids
  - Gauss law, electric field and force between the parallel plates of a plane capacitor.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Power Point, electronic correspondence (e-mail) for communication with students. Certain laboratory setups require human-instrument interaction through a computer graphical user interface. Students are encouraged to communicate with the teachers by e-mail for all matters having to do with the course. All announcements, the lab manual, the course regulations and complementary reading material are posted in the course

<table>
<tr><td></td><td>webpage. The students are encouraged to write lab reports using a computer.</td></tr>
<tr><td>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</td><td>
<table>
<tr><th>Activity</th><th>Semester workload</th></tr>
<tr><td>Lectures</td><td>52 hours</td></tr>
<tr><td>Tutorials</td><td>26 hours</td></tr>
<tr><td>5 Laboratory Exercises</td><td>5 x 2 hours</td></tr>
<tr><td>Homework</td><td>92 hours</td></tr>
<tr><td>Writing 6 laboratory repots</td><td>5 x 4 hours</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Course total</td><td>200</td></tr>
</table>
</td></tr>
<tr><td>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.</td><td>The evaluation process, as reported on the course website, is carried out in the Greek language by a series of optional tests during the course, evaluation of the written lab report which is separate for each lab exercise and is prepared by all the members of the team that conducted the experiment, and a final written examination using a combination of

- short-answered questions
- problem solving
- theory questions requiring a topic development

Students retain the right to view their exam scripts and written lab reports after grades are published and ask questions.</td></tr>
</table>

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography: (in Greek)

- R.A. Serway και Jewett, “Physics for Scientists and Engineers”, Vol II, Cengage Learning, Greek translation: Kleidarithmos Publishing (2013).
- D.C. Giancoli, “Physics for Scientists and Engineers”, Vol II, Pearson, Greek translation: Tziola Publishing (2017).
- D. Halliday, R. Resnick, J. Walker, “Physics”, Vol. II, Wiley, Greek translation: Gutenberg Publishing (2008).
- H.D. Young, “University Physics with modern Physics”, Vol. II, Pearson, Greek translation: Papazisis Publishing (2009)
- (the aforementioned books cover the course in its entirety)
- P.G. Hewitt, “Conceptual Physics”, Vol. II, Pearson, Greek translation: University of Crete Publishing (1994)
- R.P. Feynman, R.B. Leighton, Sands, M., “The Feynman Lectures on Physics”, Vol. I and II, Addison-Wesley (1963) (reference book for specialized topics)
- Emmanuel Spanakis 'Laboratory Exercises: Electricity-Magnetism', Department of Materials Science and Technology, University of Crete, Heraklion 2017 (in Greek only)
- P. Rakintzis and T. Tzouros "Notes on Laboratory III -Optics", Department of Physics, University of Crete, Heraklion 2013 (in Greek only)

EMY - 112 Mathematics II

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**EMY-112**	**SEMESTER**	**2nd**
COURSE TITLE	MATHEMATICS II		

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	**WEEKLY TEACHING HOURS**	**CREDITS**
	6	6
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	General background
PREREQUISITE COURSES:	-
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy112/

(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*

Upon successful completion of the course, students

- will be familiar with the basic concepts of vector calculus as well as the differential and integral calculus applied in many dimensions.
- will be able to apply these mathematical skills to solve problems arising in physical sciences and engineering.

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

General Competences

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

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

The course is formed in such a way, that during lectures and especially during the preparation of the written assignment (homework), that students will train themselves in:
Formulating and analyzing problems in geometry and physics by the methods of mathematical analysis

(3) SYLLABUS

1. Vector calculus. Scalar and vector product. Triple products. Gradient, divergence, continuity equation, curl, product rules, second derivatives, Laplacian, vector integration, integral theorems (Gauss,Green,Stokes's).
2. Spherical and cylindrical polar coordinates. Differential vector operations. Integration.
3. Tensors
4. Linear algebra. Vector operations and geometry in 2 and 3 dimensions. Linear transformations and matrices. Trace and determinant. Properties of determinants. Systems of linear equations. Homogeneous systems. Eigenvalue equation and its geometrical significance. Characteristic polynomial. Calculation of eigenvalues and eigenvectors. Diagonalization.
5. Application to mechanics and electromagnetism

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-Face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Computer and projector, presentation online maths software, Use of the department's asynchronous training platform (e-class) for lecture notes, exercises, questionnaires, computer tools, recording of lectures.
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	52
Exercises	26
Office hours	13
Independent study	78
Course total	**169**

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.*	Students are expected to solve exercises on a weekly basis and participate in problem solving during lectures. Their performance evaluation is carried out using • Frequent tests (every 2/3 weeks) • Final written examination .

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

In Greek

1. Calculus, W. Briggs, L. Cochran, B. Gillett, Kritiki Publishing Co. (2018)
2. Vector Calculus in the Physical Sciences, G. Leontaris and N. Bakas (2022)
3. Calculus, G. B. Thomas Jr., J. Hass, C. Heil, M. D. Weir, Crete University Press (2018)
4. Vector Calculus, Marsden και Tromba, Crete University Press (2017)

In English
Schaum's Outline of Vector Analysis, 2nd edition, by M. Spiegel, S. Lipschutz and D. Spellman

EMY - 113 Introduction to Computer Programming

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	EMY-113	**SEMESTER**	2nd
COURSE TITLE	*Introduction to Computer Programming*		

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 and programming exercises	6	5
Add rows if necessary. The organization of teaching and the teaching methods used are described in detail at (d).		
COURSE TYPE ***general background, special background, specialised general knowledge, skills development***	Compulsory, general background	
PREREQUISITE COURSES:	-	
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK	
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES	
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy113//	

(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

Upon successful completion of the course, students will

- be familiar with the basic concepts of structured programming and will be able to develop and implement simple algorithms in Python.
- be prepared to attend the computational courses of the curriculum: Advanced Computer Programming (ETY-413), as well as classes that need programming skills.
- be able to understand and develop codes in programming languages like Python.
- have gained expertise in tackling a complex problem by analysing it into many, simple, and easy tasks.

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

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…*
	…….

- Solving complex problems
- Development of scientific thinking
- Use of libraries and multiple bibliographic sources
- Search for resources and online lessons
- Create notes and stand-alone study method
- Manage time and deadlines

(3) SYLLABUS

- Python (v. 3.10+) installation, Interactive environment, code execution from command line.
- Objects, Variables, Numerical operators, Expressions, Coding rules, Modules.
- Numerical types (Integer, Float, Complex), Boolean type, Type casting, Printing, Printing formatting, Interactive input.
- Basic built-in functions (abs(), len(), range(), list(), min(), max(), etc.), Module importing, Mathematical functions of math module.
- Control commands (if…elif…else και match…case), Comparison operators, Boolean operators,

Membership operators, Identity operators, Boolean expressions.

- Looping commands (while…else, for…else), Flow change commands (break, continue, pass).
- User defined functions, Arguments, Default arguments.
- Mutable objects: Lists (Append - Delete list elements, Slicing).
- Immutable Objects: Tuples, Strings
- Basic file manipulation.

(4) TEACHING and LEARNING METHODS - EVALUATION

<table>
<tr><td>DELIVERY
Face-to-face, Distance learning, etc.</td><td>Face-to-face</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
Use of ICT in teaching, laboratory education, communication with students</td><td>Computers and projectors are used in teaching, exercises and for communicating with students (through the course website and by email). The material of the course is posted on the department's asynchronous training platform.</td></tr>
<tr><td>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</td><td>
<table>
<tr><th>Activity</th><th>Semester workload</th></tr>
<tr><td>Lectures</td><td>39</td></tr>
<tr><td>Programming exercises</td><td>39</td></tr>
<tr><td>Homework</td><td>47</td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td>Course total</td><td>125</td></tr>
</table>
</td></tr>
<tr><td>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,</td><td>Students are examined through a series of tests every week and at the end of the semester.</td></tr>
</table>

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.***	

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- Lecturer's notes
- Εισαγωγή στον Προγραμματισμό με αρωγό τη γλώσσα Python, Γιώργος Μανής, e-book: https://repository.kallipos.gr/handle/11419/2745, 2015, Κάλλιπος, ISBN: 978-960-603-415-2
- Python Εισαγωγή στους Υπολογιστές (4η αναθεωρημένη έκδοση), 2021, Ν. Αβούρης, Μ. Κουκιάς, Β. Παλιούρας, Κυρ. Σγάρμπας, Πανεπιστημιακές Εκδόσεις Κρήτης
- Το βιβλίο της Python, 2019, Ν. Σαμαράς, Κων/νος Τσιπλίδης, Εκδ. Κριτική, ISBN: 978-960-586-312-8
- Starting Out with Python (2nd ed.), 2020, Tony Gaddis, DaVinci Publ., ISBN: 978-960-973-236-9
- Μαθαίνετε εύκολα Python (3η έκδοση), Δημήτριος Καρολίδης, Εκδ. Άβακας, ISBN: 978-960-6789-30-4
- Η γλώσσα Python σε βάθος, 2023, Νίκος Χατζηγιαννάκης, Εκδόσεις ΚΛΕΙΔΑΡΙΘΜΟΣ,ISBN: 978-960-645-471-4.
- Εισαγωγή στον Προγραμματισμό Υπολογιστών με την Python, 2024, Σπύρος Πανέτσος, Εκδόσεις ΤΖΙΟΛΑ, ISBN: 978-960-418-842-0.
- Think Python (2nd edition), A.B.Downey, O'REILLY
- A Primer on Scientific Programming with Python (5th edition), Hans Peter Langtangen, Springer, 2016, ISBN 978-3-662-49886-6
- Introduction to Scientific Programming with Python, Joakim Sundnes, SIMULA - Springer Open, 2020, ISBN 978-3-030-50355-0

EMY - 122 Organic Chemistry (Theory – Laboratory)

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIAL SCIENCE AND TECHNOLOGY		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**EMY-122**	**SEMESTER**	**2nd**
COURSE TITLE	ORGANIC CHEMISTRY (Theory – Laboratory)		
INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures,*		**WEEKLY TEACHING HOURS**	**CREDITS**

laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits		
	8	8
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	GENERAL BACKGROUND	
PREREQUISITE COURSES:		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	HELLENIC	
IS THE COURSE OFFERED TO ERASMUS STUDENTS	NO	
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy122/ https://elearn.uoc.gr/	

(2) LEARNING OUTCOMES

Learning outcomes

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

Consult Appendix A

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

The organic chemistry course is an introductory course designed to provide basic organic chemistry knowledge necessary to understand and comply to other undergraduate general background courses such as chemistry of materials, polymer chemistry, biochemistry and biomaterials. During this course, the students are also acquainted with all basic laboratory techniques required for synthesis in the area of materials and biomaterials chemistry.

Upon successful completion of this course the students will be able to:
- Understand and draw the structure of widely used organic compounds and entities,
- Recognize and name the different classes of organic compounds and identify their properties,
- Know and understand all basic organic chemistry principles such as the nature of chemical bonds, isomerism, stereochemistry, chemical reactions and (curly arrow) mechanisms.
-Correlate the structure of an organic compound with physical properties (such as relative boiling point, melting point, solubility),
-Understand basic organic reaction mechanisms and use them to comprehend, design and synthesize new materials,
-To meet the needs of laboratory courses (general background and specialized courses) involving synthesis of organic compounds,
-To get acquainted with basic experimental techniques in order to meet the needs of synthesis and characterization of materials,
- To comply with safety rules, identify and mitigate potential safety hazards.
- To conduct organic chemistry experiments and properly manage generated waste.
- To use a laboratory notebook to record scientific experiments, from the planning to observation,
- To be able to use organic chemistry glassware to perform techniques such as filtration, sublimation, distillation, thin-layer chromatography, etc.
- To be able to use analytical equipment such as IR and UV.
- To apply knowledge of organic chemistry principles to solve problems in the laboratory.
- To analyze data and prepare laboratory reports.
-To work in multidisciplinary environments requiring basic organic chemistry understanding (within the framework of a diploma thesis or Erasmus).

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

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…*
	…….

- Research, analyze and synthesis in the area of organic chemistry,
- Working in interdisciplinary environments,
- Autonomous work,
- Team work.

(3) SYLLABUS

Theory: Structure, bonding, molecular properties and nature of organic compounds. Molecular representations. Acids and Bases. Alkanes and Cycloalkanes. Stereoisomerism. Stereochemistry. Chemical reactivity. Mechanisms of organic reactions. Substitution reactions. Alkenes: Structure, nucleophilic substitution and elimination reactions. Alkynes. Determination of organic compound structures: Introduction to mass spectrometry (MS), infrared spectroscopy (IR), nuclear magnetic resonance spectroscopy (NMR), ultraviolet spctrocopy (UV). Radical reactions. Introduction to Alkyl Halides, aromatic compounds, hydrocarbons, aminoacids, peptides, proteins and lipids.

Laboratory:

1. Isolation of caffeine from tea (reflux, extraction, sublimation, TLC, IR),
2. Separation of a Three Component Mixture (solubility, acidic/basic extraction, TLC),
3. sN2 Reaction (reflux, precipitation, drying, mp and/or NMR),
4. Nucleophilic substitution sN1 / Acid base indicators (heating, reaction in a small scale, indicators, halide precipitate (AgNO3)),
5. Preparation of biodiesel from vegetable oils.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	**Socrative online quizzes dedicated webpage.**
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-*	

Activity	*Semester workload*
Lectures	52 hours
Tutorials	26 hours
Laboratory Experiments	26 hours
Laboratory Reports	20 hours
Office hours	8 hours
Independent study	68 hours

directed study according to the principles of the ECTS	Course total: **200 hours**
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.*	Theory: Midterm exam (40%) and final exam (60% or 100%) containing: -Multiple choice questions, -Short-answer questions, -Organic chemistry problems. Laboratory: a) short test before experiments (20%) b) laboratory conduct (10%) c) Laboratory Journal (10%) d) Laboratory Report: delivered in electronic form one week after the experiment. The report should contain short theoretical background, methodology, observations, measurements, comments and evaluation of the results, answers to questions (60%)

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

1. Organic Chemistry for Life Sciences, David Klein, Utopia Publications, Athens, 2015.
2. Organic Chemistry, John McMurry, Crete University Press, Heraklion, 2012
3. Organic Chemistrym Clayden-Greeves-Warren I, , Utopia Publishing, Athens, 2016.
4. Laboratory manual
5. Donald L. Pavia, George S. Kriz, Gary M. Lampman, Randall G. Eng - A Small Scale Approach to Organic Laboratory Techniques - Standalone Book (2015, Cengage Learning)
6. Joaquín Isac-García, José A. Dobado, Francisco G. Calvo-Flores, Henar Martínez-García - Experimental organic chemistry _ laboratory manual-Academic Press (2016)

- Related academic journals:

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

EMY - 012 English II

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**EMY-012**	**SEMESTER**	**2nd**
COURSE TITLE	English II		

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

COURSE TYPE	GENERAL BACKGROUND & SKILLS DEVELOPMENT

general background, special background, specialised general knowledge, skills development	
PREREQUISITE COURSES:	-
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	ENGLISH
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy012/

(2) LEARNING OUTCOMES

Learning outcomes

The learning goals that students should have achieved at the end of the lesson are the following:
The course is intended to teach students English terminology on subjects of materials science and general science and scientific approach and cooperation.
It is expected that after the successful completion of the course and completion of the specified assessment, individual work, individual presentation and group work required by the students, they will be able to:

- Seek, recall and work with relative ease with texts that contain terminology related to their specialty and subject matter.
- Create various types of well-structured materials science texts and research communication documents with differentiated goals and practices.
- Easily read and understand scientific papers and communications related to their subject matter.
- Evaluate sample writing in English, and provide documentation services related to their subject matter.
- Describe in English the research results or research and experimental processes to participants and public bodies with a view to seeking international funding.
- Draw conclusions from data they find in sources in English regarding their subject matter.

Have fluency in writing, spoken interaction, listening, written comprehension, and productive speech at a level equal to or greater than the B2+ of the Common European Framework of Reference of the Council of Europe in terms of their subject matter.

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6 (comprehensive, specialised, factual and theoretical knowledge within a field of work or study and an awareness of the boundaries of that knowledge).

General Competences

The course is formed in such a way, that during lectures and especially during the preparation of the written assignment (homework), that students will train themselves in:

- *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*
- *Production of free, creative and inductive thinking*

(3) SYLLABUS

The class goal is to act as a continuation of the hands-on introduction to English academic texts and terminology related to Materials Sicence. Major topics covered: Matter and materials structure, molecular physics, polymers, modern materials science applications and scientific method, and research documentation. Further aid is offered for the familiarization with

authentic, subject specific texts and vocabulary. Development of reading skills and techniques. Additional writing skills to be developed: Introduction to EuroCVs, introduction to hands-on use of research databases and electronic resources in English. The course is taught solely in English and has the following structure:

- Nine lectures covering the main topics outlined in the class goals, supplemented by relevant texts, multimedia and exercises.
- During this course, a combination of teaching practices is used which aim to optimize the participation and learning of the participating students. Thus, in parallel with a multimedia-enhanced presentation of the themes of each lecture in English, a form of continuous assessment is carried out through a series of graded portfolio-based mini-assignments, and a final written examination.
- Learning is aided by the extensive use of the interactive e-class Edmodo platform, where all relevant notes, announcements, feedback, and so on, as well as online, multimedia and other learning resources are posted.
- The reading texts are taken from existing course books and popular scientific journals.
- The general content of the course is geared towards teaching specific terminology related to the field of the materials science department. Furthermore, it aims to familiarize students with some of the practical skills they will be required to develop as future scientists in real work environments (oral presentations, writing letters, memos, participating in group meetings, etc.).

An overall aim is the improvement of the general communication ability of students in English. During the course, students have the ability to extensively practice oral and written skills as well as comprehension skills. At the same time, emphasis is placed on group-work, peer evaluation and the use of authentic language material. In general, the structure of the course is that of blended learning.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY	Face-to-Face & Distance Learning
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY	Use of Power Point, of Board and Supportive learning through teleconference tools,
TEACHING METHODS	

Activity	***Semester workload***
Lectures	52
Written assignment (Homework) and oral presentation in the class of their written assignment	38
Course total	**90**

STUDENT PERFORMANCE EVALUATION	The evaluation is done solely in English. Students are assessed on the basis of four sub-categories: a) Selection of a paper from a scientific journal of Materials, which each student chooses to analyse and present both in writing and orally, and submission of the rationale behind the selection of a specific article. Selection of a second paper on the same topic to compare key points. Provision of written feedback to all students who submitted this assignment. This assignment follows a relevant model given to the students (3% of total grade). b) Four-minute presentation of the paper, which each student has chosen to present and compare with a second paper. Provision of written feedback to all students who submitted this assignment. This assignment follows a relevant model given to the students (17% of total grade). c) Written of final project on the above-mentioned papers. Provision of written feedback to all students who submitted this assignment. This assignment follows a relevant model given to the students (30% of total grade). d) Final examination of the material covered during the semester (50% of total grade).

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

Σταφυλίδης, Δ. (2009) Λεξικό Τεχνολογίας και Επιστημών, αγγλοελληνικό λεξικό, ελληνοαγγλικό λεξικό, τεχνικό επιστημονικό Εκδόσεις Σταφυλίδη, Αθήνα.
Sisamakis, M. (2019) Materials Science II course lecture notes (ver. 2)

- *Related academic journals:*
Indicative list of suggested academic journals for initial study and discussion:
1. Materials
2. Materials and Structures
3. Scientific American
4. New Scientist

THIRD SEMESTER

EMY - 201 Quantum Theory of Matter

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING			
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING			
LEVEL OF STUDIES	UNDERGRADUATE			
COURSE CODE	**EMY-201**	**SEMESTER**	**3rd**	
COURSE TITLE	QUANTUM THEORY OF MATTER			
INDEPENDENT TEACHING ACTIVITIES			**WEEKLY TEACHING HOURS**	**CREDITS**
			5	6
COURSE TYPE	GENERAL BACKGROUND			
PREREQUISITE COURSES:	-			
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK			
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES			
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy201/ http://esperia.iesl.forth.gr/~kafesaki/Modern-Physics/			

(2) LEARNING OUTCOMES

Learning outcomes
The course is an introduction to Quantum Mechanics and its applications to simple, basic systems, essential for the study and understanding of the structure of matter. The learning objectives that students should have achieved at the end of the course are: • To know, understand and be able to use all the concepts developed in the course concerning the behaviour of matter on a microscopic scale. • Be able to use the concepts learned and the knowledge gained to study and understand / interpret the behaviour of more complex systems than those presented in the course (eg complex atoms, molecules and their spectra, magnetic materials, light-material interaction, etc.) which are fundamental in many areas of Materials Science. • To be able to study on their own (with the bases they acquired in the course) more complex and advanced subjects of Quantum Mechanics which may be required for the study of special topics of Materials Science. *The course according to the European Qualifications Framework for Lifelong Learning belongs to level*

6.
- **General competencies**
The course aims to develop the following general competencies: -Expanded perception (ability to perceive issues outside the common experience) -Search, analyze and synthesize data and information, using the necessary technologies -Both autonomous work and teamwork capability -Creative and inductive thinking

(3) SYLLABUS

A) The crisis of Classical Physics and the Old Quantum Theory:

- The wave-particle duality for light: black body radiation, photoelectric effect, Compton effect, the particle-like nature of light
- The wave-particle duality for matter: atomic spectra, Bohr's theory, matter-waves (de Broglie waves). The position-momentum uncertainty principle, its interpretation, and its consequences (atomic stability, order of magnitude of atomic and nuclear energies, etc.)

B) Introduction to Modern Quantum Mechanics:

- Quantum mechanics in one dimension: Schrödinger equation in one dimension, wave function and its statistical interpretation. Simple one-dimensional quantum mechanical systems and quantization of energy: the infinite square well, the finite square well (qualitative study), the harmonic oscillator, the step-function potential, the rectangular barrier potential and the tunneling effect.
- Quantum mechanics in three dimensions: Schrödinger equation in three dimensions. The hydrogen atom (spherically symmetric solutions, ground state, states with angular dependence (mainly qualitatively)). Atom in a magnetic field. Spin and Pauli's Exclusion Principle. Atoms with more than one electron. The periodic system of elements. Selection Rules for atomic transitions.

C) Quantum Mechanics in more complex systems (briefly and mainly qualitatively):

- Molecules: The basic theory of chemical bonding; simple molecules (H_2, H_2O). The phenomenon of hybridization. Rotation and oscillation of diatomic molecules; molecular spectra.
- Solids: The theory of energy bands. Fermi energy. Conductors, semiconductors, insulators and their conductivity. Semiconductor doping and applications (brief description).

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY.	Face-to-Face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY	Use of an online platform for classroom testing (www.classmarker.com) Use the course web site for tests, announcements, information on useful websites, etc. Use of technology to create multiple choice exams (much program, http://eigen-space.org/mk/much/) Use and suggest related online courses from the Mathesis online course platform (http://mathesis.cup.gr/) for further study.
TEACHING METHODS	***Activity*** | ***Semester workload*** Lectures | 65

	Homework	85
	Course total	**150**
STUDENT PERFORMANCE EVALUATION	The student evaluation is done through (a) a final written exam (b) mid-term optional exam All exams are in Greek and consist of solving simple quantum mechanics problems. In some cases also multiple choice exams are given. Students can see their grades and discuss the exams outcome at the end of their assessment.	

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- Course notes from the course web-page: http://esperia.iesl.forth.gr/~kafesaki/Modern-Physics/lectures/
- Material from the online course of the platform Mathesis «Introduction to Quantum Physics I: The basic principles» (in Greek) at https://mathesis.cup.gr/courses/Mathesis/Phys1/2015_T1/course/; instructor Stefanos Trachanas
- Material from the online course of the platform Mathesis «Introduction to Quantum Physics II: The main applications» (in Greek) at https://mathesis.cup.gr/courses/course-v1:Physics+Phys1.2+18F/course/; instructor Stefanos Trachanas.
- Stefanos Trachanas, Quantum Mechanics I, Crete University Press 2005, Heraklion (in Greek)
- Stefanos Trachanas, Elementary Quantum Mechanics, e-book, Crete University Press (in Greek)
- R. Serway, Physics for Scientists and Engineers, Vol IV, translated to Greek and edited by L. Resvanis
- R. Eisberg, R. Resnick, Quantum Physics of Atoms, molecules, solids and particles, Wiley, London (1974)
- R. Feynman, Leighton and R. Sands, The Feynman Lectures in Physics, Vol III, Addison-Wesley, Reading (1965)

EMY - 211 Differential Equations

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	EMY-211	**SEMESTER**	**3rd**
COURSE TITLE	DIFFERENTIAL EQUATIONS		
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*		**WEEKLY TEACHING HOURS**	**CREDITS**

the whole of the course, give the weekly teaching hours and the total credits		
	5	6
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE	**GENERAL BACKGROUND**
PREREQUISITE COURSES:	MATHEMATICS I (EMY-111)
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy211/

(2) LEARNING OUTCOMES

Learning outcomes

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

Consult Appendix A

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

At the end of the course, students are expected:

1. To familiarize themselves with the solution of simple ordinary first and second order differential equations
2. To know very well the methodology of solving higher-order linear differential equations
3. To be able to use this knowledge to solve physical problems mainly from the fields of mechanics and electricity

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

General Competences

- Enhance the mathematical background of differential and integral calculus
- Develop critical thinking in solving physics and chemistry problems
- Promoting creative and inductive thinking

(3) SYLLABUS

Ordinary differential equations:

Introductory concepts. The problem of initial conditions. General solution of a differential equation.

1. First-order differential equations:

Equations with separable variables, first order homogeneous equations. Exact equations and integral factors. Bernoulli equation. Simple applications

2. Second-order Differential Equations:

Linear Equations with constant coefficients. Non- homogeneous equations with simple functions. Euler Equations, homogeneous and non-homogeneous. 2nd order equations reduced to 1st order because of symmetry.

3. Newton's differential Equation:

Applications to basic Mechanics problems. Motion under different friction laws in a homogeneous gravitational field. Harmonic Oscillation with and without friction. Forced Harmonic Oscillation with and without friction. Problems from electricity based on mechanical analogues.

4. General Study of Linear Differential Equations: Concepts and Techniques

The principle of superposition. Linear independence and dependence. Vronskian and its uses. Calculation of the second solution when one solution is known. Decrease of the order. Complete solution of the non- homogeneous equation when the solutions of the homogeneous are known.

5. Linear Differential Equations of higher order with constant coefficients

Homogeneous, non-homogeneous

6. Linear Differential Equations with variable coefficients

From Taylor series to Frobenius. Examples. Convergence and critical points.

7. Fourier analysis

Expansion of a function in a Fourier series. Complex representation. Fourier transform. Dirac's delta function: definition, and its properties. Application to the solution of differential equations.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-Face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY	Traditional classroom teaching and problem solving with student's participation.
TEACHING METHODS *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	52
Exercises in the class	13
Homework	85
Course total	***150***

STUDENT PERFORMANCE EVALUATION	Students are evaluated in Greek as follows: a. Optional mid-term exam (30%) b. Final examination (70%) that includes: - Solving differential equations that cover the entire course - Application Problem. Students are required to find the equation that describes the physical problem and then solve it based on the initial conditions. The problem promotes their critical and creative thinking. Students have the right to see their exam and ask questions.

(5) ATTACHED BIBLIOGRAPHY

1. S. Trachanas, Ordinary Differential Equations, Crete University Press, Heraklion (2002)

2. Thomas Kyventidis, Differential Equations, Vol I, ZHTH 1996 Thessaloniki, Greece

3. S. Trachanas, Partial Differential Equations, Crete University Press, Heraklion (2001)

4. W.E. Boyce, R.C. Di Prima, Elementary Differential Equations and Boundary Value Problems, Wiley 8th edition, 2004

5. G.F. Simmons, Differential Equations with Applications and Historical Notes, McGraw-Hill (1991)

EMY - 221 Inorganic Chemistry

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**EMY-221**	**SEMESTER**	**3rd**
COURSE TITLE	INORGANIC CHEMISTRY		
INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*		**WEEKLY TEACHING HOURS**	**CREDITS**
		5	6
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).			
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	GENERAL BACKGROUND		
PREREQUISITE COURSES:	GENERAL CHEMISTRY (EMY-121)		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES		
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy221/ https://www.materials.uoc.gr/~garmatas/teaching.html		

(2) LEARNING OUTCOMES

Learning outcomes

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

Consult Appendix A

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

The course includes an introduction to the basic principles that govern the chemical reactivity and physicochemical properties of elements with emphasis on those of transition metals. The structure of transition metal complexes in terms of chemical activity and energy stability is described.

The learning goals of the course are:
1. Consolidate the basic principles that govern the chemical reactivity of elements, especially of transition metals.

2. Acquire the knowledge necessary to understand the structure of inorganic complexes and the factors affecting their chemical stability.
3. The course aims at understanding the physicochemical principles that characterize the growth and properties of inorganic supramolecular solids.

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

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…*
	…….

- Development of interdisciplinary and critical thinking
- Search for, analysis and synthesis of data and information, with the use of the necessary technologies
- Production of free, creative and inductive thinking

(3) SYLLABUS

1. Electron Configuration and Chemical Periodicity
The physical and chemical properties and the tendency of elements to form particular compounds in relation to their position in the periodic table.

2. Acid-Base and Donor-Acceptor Principles
Pearson acid-base concept (HSAB). Definitions of Arrhenius, Bronsted-Lowry, and Lewis acids and bases. Acid-base strength classification and factors affecting it.

3. Electrochemistry
Electrode potentials, redox reactions and electrochemical cells (voltaic and electrolytic cells). Relative strength of oxidizing and reducing agents. Free energy (Gibbs) and electrical work (Standard cell potential and the equilibrium constant). The effect of concentration on cell potential (Nernst equation) Corrosion: An example of environmental electrochemistry. Protecting against corrosion.

4. Transition Elements: Electronic Configuration and Bonds
Electronic configuration and oxidation states of the transition metals and their ions. Valence bond theory and orbital hybridization. Crystal field theory. Molecular orbital theory. Crystal field splitting of energy of d-orbitals (high-spin and low-spin symmetry compounds). Strong and weak-field ligands. Spectrochemical series. Magnetic properties of transition metal complexes (paramagnetic and diamagnetic complexes). Absorption spectroscopy (electronic spectra of d^n ions, charge transfer spectra: allowed/forbidden electronic transitions). Jahn-Teller distortion. Color of transition metals.

5. Coordination Chemistry: Structure
Compounds with coordination number 2 (linear), 3 (trigonal planar and trigonal pyramidal), 4 (tetrahedral and square planar arrangement), 5 (tetragonal pyramidal and trigonal dipyramidal), 6 (octahedral and triangular prismatic), 7 (pentagonal dipyramid, substituted octahedral and substituted triangular prismatic) and 8 (triangular dodecahedron and square antiprismatic). Isomerism in coordination compounds.

6. Coordination Chemistry: Rates and Mechanisms of Chemical Reactions
Reactions of nucleophilic substitution in transition metal compounds. Trans effect. Factors that influence reaction rate. Racemic mixtures and isomerization. Electron-transfer reaction mechanisms (outer and inner sphere mechanisms).

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-Face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of Power Point, Supportive learning through the use of multimedia (videos) and valid online scientific sources, *e.g. https://ptable.com*, in order to understand the properties of chemical elements and the theories of covalent bonding.
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*	
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.*	Students are evaluated by an intermediate (optional) and final written examination in Greek that includes a combination of: - Problem solving - Developing of topics - Oral examination (for students with learning disabilities) Students have the right to view their exam scripts after the grading results are published and to ask questions. The evaluation process of the students is described during the first lecture and presented on the web site of the course: https://www.materials.uoc.gr/el/undergrad/courses/ETY223/

Activity	***Semester workload***
Lectures	48
Exercises	22
Homework	85
Course total	**155**

(5) ATTACHED BIBLIOGRAPHY

- *Suggested bibliography:*

1) "Inorganic Chemistry", 2nd Ed., Catherine E. Housecroft, Alan G. Sharpe (Greek edition: N. Hatziliadis, T. Kampanos, A. Keramidas, S. Perlepes), Unibooks IKE, 2017.
   The book comprehensively covers the syllabus of the course.
2) P.P. Karagiannidis, "Inorganic Chemistry", 3rd Ed., ZHTH Publishers, Thessaloniki, 2008.
   The book largely covers the syllabus of the course.

- *Additional bibliography:*

1) I. Tossidis, "Chemistry Coordination Compounds ", ZHTH Publishers, Thessaloniki, 2001.
2) N.D. Klouras, "Basic Inorganic Chemistry ", 2η Ed., P. Travlos Publishers, Athens, 1997.
3) Albert F. Cotton, Geoffrey Wilkinson and Paul L. Gaus, "Basic Inorganic Chemistry", 3rd ed., John Wiley & Sons, New York, 1995.
4) James E. Huheey, Ellen A. Keiter and Richard L. Keiter, "Inorganic Chemistry: Principles of Structure and Reactivity" 4th ed., HarperCollins College Publishers, New York, 1993.
5) Martin S. Silberberg, "Chemistry: The molecular nature of matter and change", 4th ed., McGraw-Hill, New York, 2006.
6) R. Chang, "Chemistry", 6th ed., McGraw-Hill, Boston, 1998

- *Related academic journals:*

Inorganic Chemistry

Coordination Chemistry Reviews European Journal of Inorganic Chemistry Journal of Inorganic Chemistry

EMY - 231 Biochemistry and Molecular Biology

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING			
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING			
LEVEL OF STUDIES	UNDERGRADUATE			
COURSE CODE	**EMY-231**	**SEMESTER**	**3rd**	
COURSE TITLE	BIOCHEMISTRY AND MOLECULAR BIOLOGY			
INDEPENDENT TEACHING ACTIVITIES			**WEEKLY TEACHING HOURS**	**CREDITS**
			4	6
COURSE TYPE	GENERAL BACKGROUND			
PREREQUISITE COURSES:	ORGANIC CHEMISTRY (EMY-122)			
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK			
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES			
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy231/			

(2) LEARNING OUTCOMES

Learning outcomes
The course outline includes an introduction to the basic concepts of molecular design of life, structure and function of fundamental biochemical molecules, biochemical evolution and the flow of genetic information. The learning goals that students should have achieved at the end of the lesson are the following: 1. To become familiar with the molecular design of life 2. To consolidate the notions of structure and function of the fundamental biochemical molecules used by nature as building blocks (nucleic acids, proteins, carbohydrates, lipids) 3. To be conceptually prepared to follow the course of natural biomaterials and their applications (course ETY-426). The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.
General Competences
- Development of interdisciplinary and critical thinking - Search for, analysis and synthesis of data and information, with the use of the necessary technology - Production of free, creative and inductive thinking

(3) SYLLABUS

• Molecular design of life • Biochemical evolution • Structure and function of proteins • DNA, RNA and the flow of genetic information • Exploring evolution • Enzymes: basic principles and kinetics • Catalytic strategies • Carbohydrates and lipids • Moreover, an invited lecture is foreseen on SwissProt and BLAST search software, along with an introductory lecture on Bioinformatics.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY	Face-to-Face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY	Use of Power Point, Supportive learning through the use of valid online scientific tools, *eg.* proteopedia.org in order to understand biological structures
TEACHING METHODS	***Activity*** / ***Semester workload*** Lectures: 52 Homework: 98 Course total: **150**
STUDENT PERFORMANCE EVALUATION	Students are evaluated by a final written examination in Greek that includes a combination of: - Multiple-choice questions - Developing of topics - Students have the right to view their exam scripts after the grading results are published and to ask questions.

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- Jeremy M. Berg, John L. Tymoczko, Lubert Stryer, Biochemistry (Greek translation), 8th Edition, Crete University Press 2018

- Related academic journals:
Biochemistry
Journal of Biological Chemistry

EMY - 241 Thermodynamic

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE STUDIES		
COURSE CODE	**EMY-241**	**SEMESTER**	**3rd**
COURSE TITLE	THERMODYNAMIC		

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
	5	6
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	General background
PREREQUISITE COURSES:	Mathematics II (ETY-112)
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy241/

(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*

Familiarize with the laws of thermodynamics and their applications with emphasis on phase diagrams of materials. Understand conditions for thermodynamic equilibrium for different materials. Rational approach to problems aiming at strict wording associated with thermodynamic laws in classical and statistical approaches. problem data and assumptions as well as quantitative analysis. Develop ability to assess knowledge and understand the physical meaning of concepts and the results of experimental or theoretical analysis.

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

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…*
	…….

Critical thinking in science in general with emphasis on quantitative analysis. Develop ability to give answers to specific questions. Work independently with emphasis on deep understanding rather than sterile memory. Feeling of self-assessment and self-criticism.

(3) SYLLABUS

The course involves a lengthy discussion of classical thermodynamics with emphasis on entropy changes and phase equilibria and a short basic introduction to statistical thermodynamics with main focus the most probable distribution and the microscopic description of entropy.

- Goal of thermodynamics, systems and equilibrium, extensional properties. Classical and statistical approaches.
- Zeroth law and temperature
- Ideal and real gases
- First law, internal energy, enthalpy
- Second law, entropy, reversibility, third law
- Free energy, chemical potential
- Phase transitions, equilibrium for one-component systems
- Mixtures, solutions, alloys. Colligative properties. Phase diagrams, equilibrium stability, phase rule.
- Basic concepts of probabilities and statistical physics. Statistical ensembles. Boltzmann distribution.
- Energy and entropy. Fundamental equations. Phase transitions.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of whiteboard, discussion and questions/answers
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*	
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.*	Mid-term exam (elective, 40% of final grade) Homework problems (elective) Final exam (mandatory, 60% or 100% if mid-term is not taken)

Activity	***Semester workload***
Lectures	52
Problems/questions	13
Study and analysis of bibliography	85
Course total	**150 hours**

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

P.W. Atkins "Physical Chemistry", 9th Edition, Greek Translation, Crete University Press
Instructor's notes on elementary statistical thermodynamics

- Related academic journals:

J. Chem. Phys., J. Phys. Chem., Chem. Eng. Education, Phys. Today, Chem. & Eng. News, Materials Today

FORTH SEMESTER

EMY - 242 Soft Matter

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**EMY-242**	**SEMESTER**	**4th**
COURSE TITLE	Soft Matter		
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**
		5	6
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).			
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	GENERAL BACKGROUND		
PREREQUISITE COURSES:	-		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES		
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy242/		

(2) LEARNING OUTCOMES

Learning outcomes

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

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European*

Higher Education Area

- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

The course is a first introduction to Soft Matter with emphasis on Polymers and Colloids. The outline includes the study of their building blocks such as the polymeric chains and colloidal particles with emphasis on their molecular characteristics, their interactions, their thermodynamic behavior and their structure and self-organization in solution.
The learning goals that students should have achieved at the end of the lesson are the following:

1. Familiarize with Soft materials and learn to distinguish between different types of systems
2. To consolidate the Physical mechanisms responsible for the structure of polymer chains their interactions and thermodynamic phase behavior.
3. To understand the role of Interparticle interactions between colloidal particles in their self-assembly in crystal phases and out of equilibrium glasses and gels
3. To provide the knowledge background for students to follow more advanced elective courses in Colloidal Dispersions and Polymer Physics (ETY-471 and ETY-450).

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

-

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…*
	…….

- Development of interdisciplinary and critical thinking
- Search for, analysis and synthesis of data and information, with the use of the necessary technology
- Production of free, creative and inductive thinking

(3) SYLLABUS

Introduction
Examples of Soft Matter systems: Polymers, Colloids, Biomaterials, Surfactants and Micelles, Liquid Crystals, Emulsions and Foams.

Polymers

1. Introduction
2. Types and names of polymeric systems
3. Basic examples in Polymer Synthesis
4. Macromolecular characterization, Chain architecture, Molecular weight, End-to-end distance and Radius of gyration
5. Solutions, concentration regimes, interactions
6. Phase behavior
7. Amorphous and Crystalline polymers. Elastomers
8. Polymer mixtures and copolymers

Colloids

1. Introduction
2. Types of colloidal systems
3. Colloidal Interaction, colloidal stabilization
4. Colloid-polymer mixtures
5. Dense suspensions and crystals
6. Colloidal glasses and gels

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face to Face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of Power Point and video material from the internet
TEACHING METHODS *The manner and methods of teaching are described in detail. Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.* *The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS*	***Activity*** / ***Semester workload*** Lectures: 52 Homework: 98 Course total: **150**
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.*	Students are evaluated by a final written exam in Greek that includes a combination of: - Questions on theory - Exercises including calculations Oral exam is foreseen for students with specific learning difficulties - Students have the right to view their exam scripts after the grading results are published and to ask questions.

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- Course notes (G. Petekidis)
- W.D. Callister, Jr. Materials Science and Engineering, An introduction,
- 5th edition, John Willey and Sons, New York, 1999.
- I. W. Hamley, Introduction to soft Matter, John Willey and Sons, New York, 2000.
- R.A.L. Jones, Soft Condensed Matter, Oxford University Press. Oxford, 2002.
- Κ. Παναγιώτου, Επιστήμη και Τεχνολογία Πολυμερών, Εκδ. Πήγασος 2000, Θεσσαλονίκη, 1996.
- Κ. Παναγιώτου, Κολλοειδή, Θεσσαλονίκη, 1998.
- D. F. Evans, H. Wennerström, The Colloidal Domain, Where Physics, Chemistry, Biology and Technology meet, 2nd Edition, John Willey and Sons, New York, 1999.

- Related academic journals:

Soft Matter, Macromolecules, Langmuir, Journal of Colloid and Interface Science, Physical Review Letters, Physical Review E

EMY - 243 Chemistry of Materials Laboratory Course

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**EMY-243**	**SEMESTER**	**4th**
COURSE TITLE	Chemistry of materials laboratory course		
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**
		7	8
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).			
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	General background		
PREREQUISITE COURSES:	EMY-121		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES		
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy243/		

(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 at the end of the course are expected to:

1. Familiarize themselves with experimental practice and safety rules during the experimental process in more demanding experiments such as composing materials.
2. To know the experimental procedures that follow for the synthesis of useful materials such as zeolites, complexes, polymers and superconductors.
3. To be able to evaluate the synthetic course of a material and to find ways to determine the result of the composition by applying appropriate characterization methods depending on the material they have to do.
4. Familiarize themselves with material characterization instruments such as the Ultraviolet-visible photometer (UV-vis), Infrared spectroscope (IR), X-ray diffraction (XRD), microscope, etc.

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and

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

(3) SYLLABUS

- Solid-state synthesis and superconductivity testing of inorganic material. Determination of average oxide state of the atoms with iodine titration.
- Hydrothermic synthesis of Zeolite NaX and characterization of the material using infrared spectroscopy.
- Synthesis and characterization of CdS nanoparticles by the aid of organic stabilizers. Characterization with UV-vis spectroscopy and X ray diffraction.
- Synthesis of single crystal hybrid organic/inorganic perovskite $CH_3NH_3PbBr_3$.
- Synthesis and optical properties of gold nanoparticle colloids. Synthesis of colloidal gold nanoparticles by the citrate gel (Turkevich) method: chemical reactions and their effect on the size and shape of the nanoparticles. Introduction in light propagation through dispersive media. Absorption, scattering and Plasmon resonance in dilute nanoparticle aqueous solutions. Nanoparticle size and shape effects on the resonant absorption of colloidal gold as measured by UV-Vis spectrometry.
- Titanium dioxide and application in photocatalysis. Synthesis of nanopowders using the sol-gel method followed by calcination in oxygen-rich ambient: study on how the chemical reactions and post-synthesis heat treatment affect the size and crystallinity of the grains. Study of the mechanism of UV-excited photocatalytic action of TiO2 on the dissociation (mineralization) of organic pollutants: case study on "methylene blue". Paths for radical formation on the surface of the grains and radical contribution to the enhancement of pollutant dissociation: effects of grain size and UV wavelength. Rate of photocatalytic dissociation: the Langmuir-Hinshelwood model.
- Hydrothermal Synthesis and Characterization of a Metal−Organic Framework by Thermogravimetric Analysis, Powder X-ray Diffraction, and Infrared Spectroscopy: An Integrative Inorganic Chemistry Experiment

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Theoretical lectures are given in the class using power point presentation. Laboratory education takes place in the laboratory face to face with the students.
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	**The reports are written from the students using personal computers and are delivered for being marked by e-mail**
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*	

Activity	***Semester workload***
Lectures	15 hours
Experiments	32 hours
Report writing	100 hours
Theory study	80 hours

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*			
	Course total	**227**	
STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	The students after the execution of the scheduled experiment, they have to write a report concerning the experiment they executed and deliver the report in a week time at the latest. In the repost they are expected to describe the theoretical background lying behind the experiment, the stages of the experiment, the measurements they acquired, the processing of the measurements and the results, comments and assessment of the results. At the end of the reports, they have to answer in some given questions in an effort to help them understand better the experimental procedure and evaluate the results. The report is written using a personal computer and is sent to the responsible by e-mail. The final grade of the lab takes into consideration the mare taken from a final exam and the average grade of the reports.		

(5) ATTACHED BIBLIOGRAPHY

• Murray Zanger, James, R. Mackee, "Small Scale Syntheses, A Laboratory Textobook of Organic Chemistry", Wm. C. Brown Publishers, 1995

• Stanley, R. Sandler, Wolf Karlo, Jo-Anne Bonesteel, Eli M. Pearce, "Polymer Syntesis and Characterization, A Laboratory Manual" Academic Press, California, USA, 1998

• Francesco Trotta, Davice Cantamessa, Marco Zanetti, "Journal Of Inclusion Phenomena and Macrocyclic Chemistry", 37, 83-92, 2000

• Gregory S. Girolami, Thomas B. Rauchfuss, Robert J. Angelici, "Synthesis and Technique in Inorganic Chemistry: A Laboratory Manual", 3rd ed., University Science Books, Sausalito, USA, 1999.

• Zvi Szafran, Ronald M. Pike, Mono M. Singh, "Microscale Inorganic Chemistry: A Comprehensive Laboratory Experience", John Wiley & Sons, New York, 1991.

• W. Haiss, N.T.K. Thanh, J. Aveyard, D.G. Fernig, "Determination of Size and Concentration of Gold Nanoparticles from UV-Vis Spectra" Anal. Chem. 79 (2007) 4215

• A. Houas, H. Lachheb, M. Ksibi, E. Elaloui, C. Guillard, J.-M. Herrmann "Photocatalytic degradation pathway of methylene blue in water" Applied Catalysis B: Environmental 31 (2001) pp. 145–157

EMY - 232 Cellular Biology and Biochemistry

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**EMY-232**	**SEMESTER**	**4th**
COURSE TITLE	Cellular Biology and Biochemistry		
INDEPENDENT TEACHING ACTIVITIES		**WEEKLY TEACHING HOURS**	**CREDITS**

		4	5
COURSE TYPE	GENERAL BACKGROUND		
PREREQUISITE COURSES:	ORGANIC CHEMISTRY (EMY-122) or BIOCHEMISTRY AND MOLECULAR BIOLOGY (EMY-231)		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES		
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy232/		

(2) LEARNING OUTCOMES

Learning outcomes
The course outline includes the study of cells and cell structures, the transport mechanisms of molecules and ions in cells, the signalling pathways and the interaction of cells with the environment. The learning goals that students should have achieved at the end of the lesson are the following: 1. To become familiar with cells, cellular structures, biochemical reactions within cells and interactions between cells-cells and cells-extracellular matrix 2. To consolidate the notions of the biochemical ques of signalling pathways to various cell responses 3. To use this knowledge towards the understanding of cellular functions 3. To be conceptually prepared to follow the course of biological materials and composite biomaterials and their applications (course ETY-491). *The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.*
- Development of interdisciplinary and critical thinking - Search for, analysis and synthesis of data and information, with the use of the necessary technology - Production of free, creative and inductive thinking

(3) SYLLABUS

1. General overview of cells and cell biological research
2. The composition of cells
3. Cellular metabolism
4. The cytoplasmic membrane
5. The cytoskeleton and cell movement
6. Cell walls, extracellular matrix and cell interactions
7. Cell signaling – Signal transduction processes

8. The cell cycle
9. Cell death and cell renewal
10. Replication, repair and recombination of DNA
11. Translation of mRNA
12. Immune system

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY.	Face-to-Face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY	Use of Power Point, Supportive learning through the use of valid online scientific tools
TEACHING METHODS	

Activity	***Semester workload***
Lectures	52
Homework	90
Course total	**142**

STUDENT PERFORMANCE EVALUATION	Students are evaluated by a final written examination in Greek that includes critical development of topics. Students have the right to view their exam scripts after the grading results are published and to ask questions.

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- Cooper Hausman, The Cell: A molecular approach
- Jeremy M. Berg, John L. Tymoczko, Lubert Stryer, Βιοχημεία (απόδοση στα ελληνικά), 8th Edition, University Press Crete 2018

- The book covers at 100% the molecular cellular biochemistry aspects of the course.
- Additional bibliography:

- Principles in Cell Biology, (2nd edition) Alberts, Bray, Hopkin, Johnson, Lewis, Raff, Roberts & Walter
- Molecular Biology of the Cell (5th edition), Alberts, Johnson, Lewis, Raff, Roberts & Walter. Garland Publishing Inc 2008.
- Molecular Cell Biology, (6th edition), Lodish, Berk, Kaiser, Krieger, Scott, Bretscher, Ploegh & Matsudaira, W.H. Freeman & Co Ltd, 2007.
- Cell Biology (4th edition), Margaritis, Galanopoulos, Keramari et al, Publisher Litsa 2004.

- Related academic journals: Journal of Cell Biology, Journal of Molecular Biology

EMY - 244 Ceramic Materials

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING			
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING			
LEVEL OF STUDIES	UNDERGRADUATE			
COURSE CODE	**EMY-244**	**SEMESTER**	**4th**	
COURSE TITLE	CERAMIC MATERIALS			
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			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*	Specialized general knowledge			
PREREQUISITE COURSES:	-			
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek			
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES			
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy244/			

(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.

It develops the basic concepts of Ceramic Materials Science. In addition to an important theoretical background in the field of ceramics, it offers students the opportunity to see the applications and possibilities of using these materials in a wide range of applications, ranging from classical applications of everyday life to advanced state-of-the-art applications, such as sensors and spacecraft units.
The course also teaches characterization and analysis techniques, which are important for the student in the industry, both in the product line and in the field of development research. following:
1. familiarizing students with ceramic materials and glasses
2. consolidation of the structural mechanisms for the creation of ceramic materials and glasses with defined properties
3. using this knowledge to properly apply ceramic materials and glasses in the various fields.

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

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?

• Develop interdisciplinary and critical thinking
• Search, analyze and synthesize data and information using the necessary technologies

• Promote free, creative and inductive thinking
• Independent work

(3) SYLLABUS

- Definition, properties, and applications of ceramic materials (sintered polycrystalline, glasses, glass-ceramics, monocrystalline and natural ceramics)
- Atomic structure
- Mechanical properties
- Thermal properties
- Electrical properties of ceramic materials
- Production of ceramic items
- Sintering
- Characteristics and analysis techniques
- Introduction to composite materials
- Projects - Presentation

(4) TEACHING and LEARNING METHODS - EVALUATION

<table>
<tr><td>DELIVERY
Face-to-face, Distance learning, etc.</td><td>FACE TO FACE</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
Use of ICT in teaching, laboratory education, communication with students</td><td>POWERPOINT, VIDEOS</td></tr>
<tr><td>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</td><td>
<table>
<tr><th>Activity</th><th>Semester workload</th></tr>
<tr><td>Lectures</td><td>39</td></tr>
<tr><td>Homework</td><td>51</td></tr>
<tr><td>Presentation</td><td>50</td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td>Course total</td><td>130</td></tr>
</table>
</td></tr>
<tr><td>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.</td><td>Students are evaluated by a final written examination in Greek that includes a combination of:
- Multiple-choice questions
- Developing of topics
And a presentation of a topic related to ceramics

Students have the right to view their exam scripts after the grading results are published and to ask questions.</td></tr>
</table>

(5) ATTACHED BIBLIOGRAPHY

Barsoum M., Fundamentals of Ceramics, 2003 Institute of Physics Publishing
Bristol and Philadelphia
Ftikos C. (2005). Ceramics Science and Technique, NTUA University Publications
Vatalis A. (2008) Material Science and Technology, Ziti Publications

www.eke.gr
www.acers.org

EMY - 245 Mechanical Design

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**EMY-245**	**SEMESTER**	**4th**
COURSE TITLE	Mechanical Design		
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**
		4	6
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*	Special background and skills development		
PREREQUISITE COURSES:			
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	No		
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy245/		

(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*

Upon completion of the course, students will:

1. Get acquainted with a CAD design software
2. Obtain state-of-the-art specialized knowledge on the principles of design and manufacturing

of two- and three-dimensional objects that consist the basis for innovative thinking
3. Obtain specialized skills in solving problems – required for research – such as skills in projecting and reproducing objects in space.
4. Have basic knowledge on 3D printing technology and methods

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

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
- Criticism and self-criticism

(3) SYLLABUS

- Introduction to the Course
- Geometrical 2-dimensional structures – Different views
- Geometrical 3-dimensional structures – Cross Sectional Views
- Graphical Representations – Diagrams
- Introductions to Mechanical Design
- Basic elements of Mechanical Design
- Manufacturing of a mechanical design
- Design and rules of standardized mechanical elements
- Specialized mechanical design elements
- Computer-Aided Design (CAD)
- 3D printing basics.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of 2D and 3D CAD software packages
TEACHING METHODS *The manner and methods of teaching are described in detail.*	

Activity	***Semester workload***
Lectures	52 hours

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*	Laboratory Practice	20 hours
	Study and analysis of bibliography	78 hours
	Course total	**150 hours**
STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	The evaluation of the students is performed in Greek language, through 3 different procedures. 1. During the lab via: - *Short-answer questions* - *Problem solving* - *Laboratory work* 2. *Progress exam covering approximately half of the material* 3. *Final exam* *At the exams the student is expected to deliver 2D models in printable format according to the rules of engineering design and 3D models.*	

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- Lectures' Notes
- Μηχανολογικό Σχέδιο- Αριστομένης Θ. Αντωνιάδης Εκδόσεις Τζιόλα
- Engineering Drawing and design David P. Madsen- David A. Madsen

FIFTH SEMESTER

EMY - 301 Solid State Physics

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING			
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING			
LEVEL OF STUDIES	UNDERGRADUATE			
COURSE CODE	**EMY-301**	**SEMESTER**	**5th**	
COURSE TITLE	SOLID STATE PHYSICS			
INDEPENDENT TEACHING ACTIVITIES		**WEEKLY TEACHING HOURS**	**CREDITS**	
		5	6	
COURSE TYPE	GENERAL BACKGROUND			
PREREQUISITE COURSES:	QUANTUM THEORY OF MATTER (EMY-201)			
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK			
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES			
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy301/ http://theory.materials.uoc.gr/courses/fsk/			

(2) LEARNING OUTCOMES

Learning outcomes
By the end of the course, students are expected to: 1. Become familiar with quantities that tell if a material is (a) hard or soft (b) heats up easily or not (c) conducts electricity (d) is transparent or (e) is affected by magnetic fields. 2. Know simple crystal structures and calculate their basic structural properties, as well as quantities that describe the main properties of a material and the characteristic order of magnitude for their numerical values. 3. Have learned to calculate the approximate density, the distance between adjacent atoms, modulus, heat capacity, dielectric constant, refractive index, magnetoresistance in simple solids. They should have understood the mechanisms of quantum motion of electrons and the thermal motion of atoms in solids. *The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.*
- Development of interdisciplinary and critical thinking - Search for, analysis and synthesis of data and information, with the use of the necessary technology - Production of free, creative, and inductive thinking

(3) SYLLABUS

This course is an introduction to the relationships connecting atomic structure and macroscopic properties

of solids. It includes an introduction to the calculus of periodic functions of three variables, including Bravais Lattices and crystal structures. Using simple models, all key properties of solids are introduced to the students, including mechanical, thermal, electrical, optical and magnetic properties. Relationships between quantities that describe different properties are highlighted.

Course content:

A. Introduction

- Chemical bonding in solids. Structure and key physical properties of solids. Estimation of order of magnitude for key quantities.

- B. Structure of Crystalline Solids

  - Periodicity in three dimensions. Bravais Lattices, crystal lattices, lattice vectors. Reciprocal Lattice, Brillouin Zone, Bloch's theorem.
  - Electronic structure: Schrodinger equation in homogeneous solid (Jellium). Fermi model. Band structure.
  - Phonons: Transverse and Longitudinal waves, thermal motion, quantum zero-point motion. Phonons in homogeneous solid. Debye model.

- Γ. Response of crystalline solids

  - Pressure: effect of mechanical strain on atomic and electronic structure. Bulk modulus and other moduli.
  - Temperature: effect of temperature changes on the atomic and electronic structure. Heat Capacity, therrmal expansion, thermal conductivity.
  - Electric Field: electrical conductivity and dielectric constant in Drude's model. Plasmons.
  - Magnetic field: Hall effect and magnetoresistance.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY.	Face-to-Face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY	Use of Power Point, Supportive learning using valid online scientific tools, *eg.* Phonon-website to understand phonons.
TEACHING METHODS	
STUDENT PERFORMANCE EVALUATION	Students are evaluated by a final written examination in Greek that includes a combination of: - Multiple-choice questions - Developing of topics - Students have the right to view their exam scripts after the grading results are published and to ask questions.

Activity	***Semester workload***
Lectures	65
Homework	64
Guided problem solving	26
Course total	**155**

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- E. N. Οικονόμου, Φυσική Στερεάς Κατάστασης, Πανεπιστημιακές Εκδόσεις Κρήτης (1997-2003)
- C. Kittel, Introduction to solid state physics , Wiley, New York (1976)
- R. A. Levy, Φυσική Στερεάς Κατάστασης, Εκδόσεις Πνευματικού, Αθήνα (1978)
- N. W. Ashcroft - N. D. Mermin, Solid state physics, Holt, Rinehart and Winston, New York (2012)
- Σ. Τραχανάς, Κβαντομηχανική Ι, Πανεπιστημιακές Εκδόσεις Κρήτης (2005)
- E. Kaxiras, Atomic and electronic structure of solids, Cambridge University Press (2003)

- Related academic journals:
Physical Review B
Journal of Chemical Physics
Physica Status Solidi
Solid State Communications
Journal of Physics: Condensed Matter

EMY - 341 Biomaterials

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**EMY-341**	**SEMESTER**	**5th**
COURSE TITLE	Biomaterials		
INDEPENDENT TEACHING ACTIVITIES		**WEEKLY TEACHING HOURS**	**CREDITS**
		4	5
COURSE TYPE	GENERAL BACKGROUND		
PREREQUISITE COURSES:	Organic chemistry (EMY-122) or Biochemistry and molecular biology (EMY-231) or Cell biology and biochemistry (EMY-232)		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES		
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy341/		

(2) LEARNING OUTCOMES

Learning outcomes
The course outline includes the study of biomaterials and composite biomaterials, their physicochemical and mechanical properties, their degradation mechanisms, their biocompatibility criteria and evaluation, the biological responses following an implantation. The learning goals that students should have achieved at the end of the lesson are the following: 1. To become familiar with biomaterials and composite biomaterials

2. To consolidate the notions of the structural mechanisms used by Nature to create materials with defined properties
3. To use this knowledge towards the design of biocompatible materials
3. To be conceptually prepared to perform a diploma thesis in a research laboratory in the area of biomaterials, tissue engineering and regenerative medicine

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

- Development of interdisciplinary and critical thinking
- Search for, analysis and synthesis of data and information, with the use of the necessary technology
- Production of free, creative and inductive thinking

(3) SYLLABUS

1. Materials for Biomedical Applications
2. Chemical Structure of Biomaterials
3. Physical Properties of Biomaterials
4. Mechanical Properties of Biomaterials
5. Biomaterial Degradation
6. Biomaterial Processing
7. Surface Properties of Biomaterials
8. Protein Interactions with Biomaterials
9. Cell Interactions with Biomaterials
10. Biomaterial Implantation and Acute Inflammation
11. Wound Healing and the Presence of Biomaterials
12. Immune Response to Biomaterials
13. Biomaterials and Thrombosis
14. Infection, Tumorigenesis and Calcification of Biomaterials

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY.	Face-to-Face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY	Use of Power Point, Supportive learning through the use of valid online scientific tools
TEACHING METHODS	

Activity	***Semester workload***
Lectures	52
Homework	90
Course total	**142**

STUDENT PERFORMANCE EVALUATION	Students are evaluated by a final written examination in Greek that includes critical development of topics. Students have the right to view their exam scripts after the grading results are published and to ask questions.

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- Book "Biomaterials – The interface between Biology and Materials Science", J.S. Temenoff, A.G. Mikos, Edition Utopia, ISBN: 978-618-5173-27-2 (book translated in greek language)
  - The text book covers 100% of the examination matter.

- Additional bibliography:
- B. D. Ratner, A. S. Hoffman, F. J. Schoen, J. E. Lemons, "Biomaterials Science: An Introduction to Materials in Medicine", Academic Press, 2004
- J. S. Temenoff, A. G. Mikos, "Biomaterials: The Intersection of Biology and Materials Science", 2008
- J. B. Park, J. D. Bronzino, “Biomaterials - Principles and Applications“, CRC, 2002
- D. F. Williams, "Fundamental Aspects of Biocompatibility", Volume 1, CRC, 1981
- D. F. Williams, "Biocompatibility of Orthopedic Implants", CRC, 1982
- D. F. Williams, "Techniques in Biocompatibility Testing", CRC, 1986
-
- *- Related academic journals:*
- Biomaterials, Acta Biomaterialia, Regenerative Biomaterials, Dental Materials, Journal of Materials Science-Materials in Medicine, Tissue Engineering Parts A, B, C, Journal of Biomedical Materials Research

EMY - 342 Mechanics of Materials

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**EMY-342**	**SEMESTER**	**5th**
COURSE TITLE	Mechanics of Materials		
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 and exercises	3+1	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*	General background		
PREREQUISITE COURSES:			
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES		
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy342/		

(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*

Introductory course to the mechanics of materials. Covers fundamental principles of statics and solid mechanics related to the structure and properties of materials.

Upon successful completion, students will:

• Be able to draw free-body diagrams and apply the equations of equilibrium.

• Understand the concepts of external and internal forces and be able to calculate reactions, internal forces in isostatic structures under mechanical loading.

• Know the concepts of stress, strain, displacements and the fundamental constitutional laws that relate them in various types of materials (elastic, plastic, anisotropic, viscoelastic).

• Be able to calculate stress fields in cross-sections of one-dimensional isostatic structures (beams, shafts, axles) subjected to tension, torsion or bending.

• Understand the concepts of force flow, stress flow and stress concentration.

• Understand the concepts of static and cyclic loadings and stresses.

• Be able to apply Mohr's circle to calculate principal stresses in complex stress fields.

• Be able to apply failure criteria in ductile or brittle materials in order to size components.

• Know the concepts of fatigue and be able to evaluate the failure of a components under cyclic loading.

• Know the concept of buckling and can seize columns.

• Be able to calculate displacements in one-dimensional isostatic components under tesion, torsion or bending.

• Be able to calculate reactions, stresses and displacements in hyperstatic components.

• Know the concepts of linear, torsional and bending springs.

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

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…*
	…….

• Promote free, creative and inductive thinking.
• Apply concepts in component design.

(3) SYLLABUS

• Newton's laws. Linear and translational motion. Vector descriptions of forces and moments. Coordinate systems. Degrees of freedom.
• Concentrated and distributed forces. Equivalent force.
• Solid body equilibrium. Free body diagrams. Internal and external forces. Supports, reactions and loadings.
• Types of structures. Stability. Statically determinate structures.
• Static and cyclic loadings. Semi-equilibrium solutions. Principle of superposition.
• Internal forces in one-dimensional structures. Trusses. NQM diagrams.

• Stress, strain, displacements and deformatoions. Normal and shear stress and strain. Constitutive equations of isotropic elastic materials. Hooke's law.
• Stresses in one-dimensional structures under tension, torsion or bending.
• Stress flow. Stress concentration. Stress concentration factors.
• Analysis of complex stress fields. Mohr's circle. Principle stresses. Stress fields in one-dimensional structures under combined loading.
• Stress-strain curves. Stiffness. Young's Modulus. Yield stress. Ultimate stress. Ductility. Toughness. Real stress and strain. Elastic and plastic materials. Ramberg-Osgood equation.
• Dangerous section. Allowable stress. Safety factor.
• Failure of ductile and brittle materials in static loading. Failure criteria (Tresca, Von Mises, Mohr).
• Fatigue. Crack generation and propagation. S-N diagrams.
• Buckling. Displacement stability. Euler equation. Secant equation.
• Displacements in one-dimensional structure under tension, torsion or bending.
Causality of displacements and loads.
• Analysis of strain fields. Mohr's circle for strains.
• Calculation of reactions, stresses and displacements in hyper-static structures.
• Constitutive equations of materials. Isotropic and anisotropic materials. Viscoelastic materials. Poroelastic materials.
• Strain, force and torque measurements.
• Generalized Hooke's law. Introduction to numerical methods of structure analysis.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Dedicated webpage, Book chapters, review articles, research papers, templates available on Moodle
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*	
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.*	

Activity	***Semester workload***
Lectures	39
Presentations	13
Office hours	73
Independent study	
Course total	**125**

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- Νικόλας Αράβας, Μηχανική των Υλικών (2η έκδοση), Εκδόσεις Τζιόλα, 2023.
- Beer-Johnston-Dewolf-Mazurec, Μηχανική των Υλικών (2η έκδοση), Εκδόσεις Τζιόλα, 2010

- Related academic journals:

EMY - 343 Soft Matter Laboratory

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	EMY-343	**SEMESTER**	5th
COURSE TITLE	Soft Matter Laboratory		
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**
		7	8
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*	Special background, Skills Development		
PREREQUISITE COURSES:	EMY-242		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	NO		
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy343/		

(2) LEARNING OUTCOMES

Learning outcomes

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

Consult Appendix A

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

The course includes an introduction to the basic principles of synthesis and characterization of soft materials (polymers and colloids).

The learning objectives of the course are as follows:

1. To provide students with theoretical knowledge and practical familiarity with the basic methods of synthesis and macromolecular characterization of polymers and colloids.

2. Theoretical and practical training of students in basic techniques for studying the thermal and surface properties of soft materials.

3. Preparation of students for the completion of a thesis or postgraduate studies.

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

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…*
	…….

- Development of interdisciplinary and critical thinking
- Searching for, analyzing, and synthesizing data and information, using the necessary technologies
- Practical familiarization with methods and techniques
- Independent work
- Teamwork
- Promotion of free, creative, and inductive thinking

(3) SYLLABUS

• Theory

Introduction:

Types of Polymers, Colloids, Nomenclature, Polymerization Techniques, Molecular Weight, Size-Shape of Polymers, Applications

Polymerization Methods & Polymer Reactions:

Stepwise, Free Radical, Ion, Copolymerization

Molecular Characterization of Polymers:

Determination of Absolute Molecular Weight (Static Light Scattering)

Size Exclusion Chromatography (SEC)

Viscometry

Thermal Properties:

Crystallization, Glass Transition, Elastomers, Transition Determination Methods

Surface Properties:

Interfacial Tension, Young's Equation, Contact Angle, Wettability

• Laboratory Exercises

1. Synthesis of Soft Materials

1.1 Preparation of Homopolymer Polystyrene Using the Free Radical Mass Polymerization Technique

1.2 Preparation of Random Copolymer Polystyrene-co-poly (butyl methacrylate) using the Free Radical Solution Polymerization Technique and Nylon 6.10 using the Two-Phase Polycondensation Polymerization Technique

1.3 Synthesis of Polystyrene Colloidal Particles Using the Emulsion Polymerization Technique

1.4 Preparation of Random Polymeric Acrylic Acid Network

2. Characterization of Soft Materials

2.1 Study of Molecular Weight Distribution by Size Exclusion Chromatography (SEC)

2.2 Structural and Morphological Characterization of Polymers Using Differential Scanning Calorimetry (DSC)
2.3 Thermal Resistance of Polymers and Composite Materials Using Thermogravimetric Analysis (TGA)
2.4 Modification of the Wettability of a Solid Surface by Depositing Polymeric Materials and Measuring the Contact Angle
3. Biomaterials
3.1 Drug delivery with the aid of polymers: release of salicylic acid from poly(lactic-co-glycolic acid)
3.2 Isolation of Milk Proteins and Quantitative Determination of Proteins by Bradford

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of PowerPoint, communication via the Department's website and email Use of reliable scientific online sources to find bibliography and present topics to students
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*	
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.*	Formative (Assessment of progress without grade consequence) Students are assessed through written tests and questions during laboratory exercises, through the grading of laboratory reports, and through a final written exam that includes a combination of problem solving and essay questions. There is the possibility of an oral exam for students with learning difficulties. Students have the right to see their written exam after the results have been released and to ask questions. The method of student assessment and the percentage of each activity in the final grade are described during the first lecture, given to students in writing, and also posted on the course website: https://www.materials.uoc.gr/courses/emy343/

Activity	***Semester workload***
Lectures	32
Laboratory exercises	45
Study of bibliography at home	33
Writing of laboratory report	90
Course total	**200**

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- Προτεινόμενη Βιβλιογραφία:

- ΕΡΓΑΣΤΗΡΙΑΚΕΣ ΑΣΚΗΣΕΙΣ ΣΥΝΘΕΣΗΣ ΚΑΙ ΧΑΡΑΚΤΗΡΙΣΜΟΥ ΧΑΛΑΡΩΝ ΥΛΙΚΩΝ, Μ. Βαμβακάκη, Σ. Παρούτη, Κ. Χρυσοπούλου, Ηράκλειο, Σεπτέμβριος 2004.
- Allcock, H.R.; Lampe, F.W. Contemporary Polymer Chemistry, 2nd ed., Prentice Hall, Englewood Cliffs, 1990.
- Hiemenz, P.C. Polymer Chemistry: The Basic Concepts, Marcel Dekker, NY, 1984.
- Young, R.J.; Lovell, P.A. Introduction to Polymers, 2nd ed., Chapman & Hall, 1996.

- Πρόσθετη βιβλιογραφία:
- Related academic journals

- Brandrup, J. and Immergut, E.H., eds., Polymer Handbook, 3rd ed., John Wiley & Sons, New York, 1989.
- Odian, G. Principles of Polymerization, 3rd ed., John Wiley & Sons, New York, 1991.
- Rempp, P.; Merill, E.W. Polymer Synthesis, 2nd ed., Huthig & Wepf, Basel, 1991.
- Cowie, L.M.G. Polymers: Chemistry and Physics of Modern Materials, 2nd ed., Chapman & Hall, Padstow, Cornwall, UK, 1998.
- Stevens, M.P. Polymer Chemistry: An Introduction, 2nd ed., Oxford Univ. Press, 1990.
- Flory, P.J. Principles of Polymer Chemistry, Ithaca, HY, Cornell University Press, 1953.
- Σιμιτζή, Ι. Χρ. Επιστήμη Πολυμερών, Έκδοση Εθνικού Μετσοβείου Πολυτεχνείου, Αθήνα, 1994.
- Παναγιώτου Κ. Επιστήμη και Τεχνολογία Πολυμερών, Εκδόσεις Πήγασος2000, Θεσσαλονίκη, 1996.

EMY - 344 Transport Phenomena in Materials Science

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	EMY-344	**SEMESTER**	5th
COURSE TITLE	Transport Phenomena in Materials Science		
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**
		5	6
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*	Special background		
PREREQUISITE COURSES:	EMY-211		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes		
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy344/		

(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*

Upon completion of the course students should:

1. have familiarity with Fourier's, Newton's and Fick's Laws for heat, momentum and mass transfer.

2. be able to establish conservation equations and necessary initial and boundary conditions, and decide on

sufficient assumptions.

3. solve in detail some simplified cases.

4. recognize qualitative solutions of complex cases and understand temperature, velocity and concentration distributions.

5. apply the above to basic problems of heat, momentum and mass transfer in materials e.g. insulation, Newtonian fluid flow, evaporation.

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

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…*
	…….

1. Analysis and synthesis of data and information using the necessary (theoretical, and basic computational and experimental) technologies. Develop critical thinking to select appropriate assumptions for problem solving.

2. Work in an interdisciplinary environment. Transport phenomena concern various properties of materials, materials of various phases and are applied in a wide range of cases.

3. Development of synthetical thinking. Transport phenomena are presented in Nature as a combination of the sub-cases we study. Their combination requires the individual understanding of each phenomenon and the synthesis. e.g. induced convection.

4. Individual project on a topic chosen by the student promotes free, creative thinking and autonomous work.

(3) SYLLABUS

1. Introduction to the unified presentation of Transport Phenomena. Laws of conservation. Review of vectors and tensors.

2. Heat transport mechanisms. Thermal conduction, Fourier's Law. Convection, forced convection, radiation.

3. Setup of equations, initial and boundary conditions and solution in one dimension. Graphical solutions in 2d with known boundary conditions.
Macroscopic balance.
Simple example of time-dependent heat transport under assumptions e.g. lumped capacitance method.

4. Fluid statics. Viscosity. Momentum transfer. Flow lines.
Macroscopic balance. Mechanical energy – Bernoulli equation. Reynolds Transport Theorem. Dimensional analysis.
Microscopic momentum balance for laminar isothermal flow. Simple solutions in Cartesian and non-Cartesian coordinate systems.

5. Mass transfer. Diffusion. Molecular description.
Macroscopic balance. Microscopic balance of mass flow in laminar flow.

(4) TEACHING and LEARNING METHODS - EVALUATION

<table>
<tr><td>DELIVERY
Face-to-face, Distance learning, etc.</td><td>Face-to-face</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
Use of ICT in teaching, laboratory education, communication with students</td><td>Use of educational videos, use of open-source software with example data, online mathematical tools for solving/plotting solutions. Use of e-class for distribution of lecture notes, videos, links, questionnaires, suggested and solved exercises.</td></tr>
<tr><td>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</td><td>
<table>
<tr><th>Activity</th><th>Semester workload</th></tr>
<tr><td>Lectures</td><td>52 hrs (4 εβδομαδιαίως)</td></tr>
<tr><td>Exercise section</td><td>13 hrs (1 εβδομαδιαίως)</td></tr>
<tr><td>Office hours</td><td>13 hrs</td></tr>
<tr><td>Optional Project</td><td>20 hrs</td></tr>
<tr><td>Independent study</td><td>65 hrs (5 εβδομαδιαίως)</td></tr>
<tr><td>Course total</td><td>163</td></tr>
</table>
</td></tr>
<tr><td>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.</td><td>Formative (Assessment of progress without grade consequence)
- Weekly suggested exercises
- Oral participation in solving problems during lectures

Conclusive (Evaluation with grading consistency)
- Three midterms: one at the end of each conceptual unit (heat, momentum, mass transfer)
- Project (optional)
- Final written exam

The summative assessment is detailed on the first day of the course and in the syllabus, and is referenced in the e-class.</td></tr>
</table>

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

In Greek (in Evdoxos)

1. Μεταφορά θερμότητας και μάζας, Αραμπατζής Γ., Ασημακόπουλος Δ., Λυγερού Β. (1η έκδοση 2020), εκδόσεις Τζιόλα

2 Εισαγωγή στη Μηχανική των Ρευστών – digital book, freely available to the academic community at Kallipos repository https://repository.kallipos.gr/handle/11419/5345

Other relevant, useful textbooks

In Greek

1. Εισαγωγή στα Φαινόμενα Μεταφοράς, R.B. Bird, W. E. Stewart, E. N. Lightfoot, D.J. Klingenberg. Εκδόσεις Τζιόλα. (2η έκδοση)
2. Μηχανική των Ρευστών, 3η έκδοση. Α. Θ. Παπαϊωάννου. Εκδόσεις Σοφία (2020)
3. Schaum's: Δυναμική Ρευστών, W. F. Hughes, J. A. Brighton, εκδόσεις Τζιόλα
4. Μεταφορά θερμότητας και μάζας από τη Φυσική στη Μηχανολογία, (1η έκδοση 2022) εκδόσεις Τσότρας.
5. Μηχανική ρευστών, Munson, Young, Okiishi, εκδόσεις Τζιόλα

In English

1. Alexander Smits, A physical Introduction to Fluid Mechanics, Wiley, 2000
2. Introduction to Heat Transfer (6th ed.), by T.L. Bergman, A.S. Lavine, F.P. Incropera, D.P. Dewitt. Willey Eds.

- *Related academic journals*

Journal of Fluid Mechanics, Physical Review Fluids, Physics of Fluids, AIChE Journal

SIXTH SEMESTER

EMY - 345 Materials Characterization Methods

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING			
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING			
LEVEL OF STUDIES	UNDERGRADUATE STUDIES			
COURSE CODE	**EMY-345**	**SEMESTER**	**6th**	
COURSE TITLE	Materials Characterization Methods			
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**
			4	6
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*	Specialised general knowledge. Special background			
PREREQUISITE COURSES:	EMY-141			
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek			
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES			
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy345/			

(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*
A. The knowledge which the students will acquire upon successful completion of the course comprises: Radiation-matter interaction. Basic principles and concepts of using modern spectroscopic techniques in the field of materials science. Theory of elastic scattering. Elastic scattering from isolated atoms. Theory of X-Ray and electron diffraction. Secondary emission. Absorption of radiation from materials. Emission-detection-measurement of radiation. X-ray photoelectron spectroscopy (XPS) and Auger electron spectroscopy, scanning and transmission electron spectroscopy, energy dispersive X-ray spectroscopy (EDS) for analysis of materials surfaces and interfaces. UV-vis spectroscopy, Infrared spectroscopy (FT-IR) and Raman spectroscopy.

B. The skills which the students will acquire upon successful completion of the course are:
a) mastering real-life experimental techniques and instrumentation, which are widely used for the structural and chemical characterization of materials, such as X-Ray diffractometry, X-ray photoelectron spectroscopy (XPS), Auger electron spectroscopy (AES), scanning and transmission electron microscopy and EDS analysis, UV-vis spectroscopy, Infrared spectroscopy (FT-IR) and Raman spectroscopy.
b) choosing the right instruments or equipment for the chemical and structural analysis of materials.

C. The competence which the students will acquire upon successful completion of the course is
a) the ability to decide on and properly utilize the proper experimental technique for a specific structural and/or chemical characterization of materials
b) the ability to correctly assess and utilize results presented by other scientists regarding the aforementioned specific characterizations of different classes of materials.

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

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. Production of free, creative and inductive thinking.

(3) SYLLABUS

Introduction
Types of radiation, energy-wavelength relation, radiation applications to materials science, atomic theory, atomic energy levels.

Radiation-Matter interaction
Electromagnetic waves, electromagnetic spectrum, ionizing (X-Ray) and non-ionizing radiation, study of the interaction of beams with electrons/neutrons/ions. Basic principles of elastic scattering (amplitude/intensity of radiation). Elastic scattering from isolated atoms.

X-Ray diffraction
Theory, Emission of X-rays and affecting factors (potential, current etc), Absorption of X-rays, Detection of X-rays and measurement of their intensity, Crystallography, Crystal lattice, Primitive cell, Crystalline planes, Instrumentation, Application of X-rays diffraction to materials characterization (composition, crystal phases, crystallite size etc.).

X-Ray Photoelectron Spectroscopy (XPS) and Auger electron spectroscopy (AES)
Principle of operation, photoelectric effect, binding energy, chemical shift, satellite peaks, XPS peak splitting and spin-orbit coupling, theory of auger electron spectroscopy, applications of XPS and AES.

Energy dispersive X-ray spectroscopy (EDS)
Principle of operation, electronic transitions, emission of characteristic X-rays, energy dispersive X-ray spectroscopy (EDS), characteristic EDS spectra, applications.

Electron microscopy

Aspects of an optical microscope (focusing lens, objective lens, magnification), scanning electron microscopy (SEM), SEM instrumentation, examples, transmission electron microscopy (TEM), TEM instrumentation, examples, comparison between SEM/TEM microscopes, combination of an electron microscope with energy dispersive spectroscopy (EDS).

Ultraviolet-Visible (UV-Vis) spectroscopy
Beer-Lambert Law, Electronic transitions, Visible range of the spectrum, Color - wavelength relation, Typical examples of chemical compound spectra, Absorption/Transmission/Reflection spectra in liquid and solid samples.

Fourier Transform - Infrared spectroscopy (FT-IR)
Dipolar moment, Vibrational/Rotational energy levels, Types of molecular vibrational motion, Selection rules, Instrumentation, Michelson Interferometer, Typical FT-IR spectra of organic compounds, Attenuated Total Reflectance (ATR), Applications.

Raman spectroscopy
Basic principles, Stokes/Anti-Stokes lines, Polarization, Vibration - Rotation types, Selection rules, Comparison with FT-IR: similarities and differences, laser, Instrumentation, Typical Raman spectra of organic and inorganic compounds / materials, Applications.

(4) TEACHING and LEARNING METHODS - EVALUATION

<table>
<tr><td>DELIVERY
Face-to-face, Distance learning, etc.</td><td>Lectures, Visits to research laboratories - Instrument demonstration</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
Use of ICT in teaching, laboratory education, communication with students</td><td>Lectures are given as computer-based slide-show presentations. Students are encouraged to communicate with the teachers by e-mail for all matters having to do with the course. All announcements, the lectures, the course regulations and complementary reading material are posted in the course webpage.</td></tr>
<tr><td>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</td><td>
<table>
<tr><th>Activity</th><th>Semester workload</th></tr>
<tr><td>Lectures</td><td>14 hours</td></tr>
<tr><td>Educational visits</td><td>8 hours</td></tr>
<tr><td>Final lecture and answering students’ questions</td><td>4 hours</td></tr>
<tr><td>Study before the final written exam</td><td>50 hours</td></tr>
<tr><td>Study and analysis of bibliography</td><td>41 hours</td></tr>
<tr><td>Final Exam</td><td>3 hours</td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td>Course total</td><td>150 hours</td></tr>
</table>
</td></tr>
<tr><td>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,</td><td>The course teaching and student evaluation regulations are permanently posted in the course webpage. Students are evaluated by their presence and participation in the lectures and the final written examination, which intends to give proof of the knowledge that the student should have acquired after taking the course.</td></tr>
</table>

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

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- *J. P. Eberhart, "Structural and Chemical Analysis of Materials", John Willey & Sons Inc., 1991.*
- *P. Atkins, J. De Paula, "Φυσικοχημεία" Πανεπιστημιακές Εκδόσεις Κρήτης, 2018*
- *D.C. Harris, M.D. Bertolucci, "Symmetry and Spectroscopy" (Dover, NY 1978)*
- *P.E.J. Flewitt, R.K. Wild, "Physical Methods for Materials Characterization", IOP Publ., London (1994)*
- *H.-M. Tong and L.T. Nguyen, Eds., "New Characterization Techniques for Thin Polymer Films", Wiley, New York (1990)*
- *D. A. Skoog, F. J. Holler and T. A. Nieman, "Principles of Instrumental Analysis", 5th Edition, Saunders College Publishing, Philadelphia (1998)*

EMY - 346 Microelectronic Materials

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**EMY-346**	**SEMESTER**	**6th**
COURSE TITLE	MICROELECTRONIC MATERIALS		
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**
		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*	GENERAL BACKGROUND		
PREREQUISITE COURSES:			
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES, AS READING COURSE		
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy346/		

(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*

- Understand basic structural and electronic properties of semiconductors associated with crystalline structure, energy bands and impurities.
- Understand the physical principles of operation of significant semiconductor devices.
- Knowledge of basic semiconductor growth and fabrication processes such as optical lithography, thermal and e-beam metal and dielectric deposition, wet and dry chemical etching.
- General overview of modern developments in the rapidly expanding field of microelectronic semiconductor devices.
- Be prepared to attend more specialized undergraduate or postgraduate courses on semiconductor physics and devices

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

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
- Production of free, but structured, creative and inductive thinking
- Working independently

(3) SYLLABUS

The aim of the course is introduction to fundamental properties of semiconductor materials and their application in modern microelectronic devices.

- Introduction to semiconductors - crystal structures
- Material growth and basics of semiconductor device fabrication - photolithography
- Energy bands – reciprocal lattice - Brillouin zone
- Bandgaps in semiconductors – properties of conduction and valence bands – parabolic bands – holes
- Density of states – bandgap engineering – quantum wells
- Fermi statistics – intrinsic and extrinsic carrier concentrations – n and p type doping - Fermi energy level
- Charge transport in semiconductors by diffusion and drift
- P-N diodes – principles of operation – basic circuits with diodes
- Bipolar transistor
- FET transistor

(4) TEACHING and LEARNING METHODS - EVALUATION

<table>
<tr><td>DELIVERY
Face-to-face, Distance learning, etc.</td><td>Face-to-Face</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
Use of ICT in teaching, laboratory education, communication with students</td><td>Use of teleclass for communication and for uploading material related to the lectures. Use of Power Point. Support for learning by using multimedia (videos) and scientific web resources to display additional information when required.</td></tr>
<tr><td>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</td><td>
<table>
<tr><th>Activity</th><th>Semester workload</th></tr>
<tr><td>Lecture presentation</td><td>36</td></tr>
<tr><td>Problem solving</td><td>12</td></tr>
<tr><td>Research Laboratory visits</td><td>2</td></tr>
<tr><td>Study at home. Problem solving and theory reading</td><td>75</td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td>Course total</td><td>125 hours</td></tr>
<tr><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>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.</td><td>Students are evaluated either by written final exam (100%) or by combination of written final exam (80%) and three homeworks (20%). The final exam is in Greek and includes:
•Problem solving
• Developing of topics
Oral examination is foreseen for students with learning difficulties.

Students have the right to check and ask questions on their written exam material once the grading process is completed.

The method of student evaluation and course material is described in the first lecture and is available in the teleclass space of the course.</td></tr>
</table>

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

(1) *J. Singh «Οπτοηλεκτρονική» 2016*

(2) *Sedra/Smith «Μικροηλεκτρονικά Κυκλώματα»*

(3) *Streetman & Banerjee "Solid State Electronic Devices"*

(4) *Pierret "Semiconductor Device Fundamentals"…"*

EMY - 347 Magnetic Materials

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**EMY-347**	**SEMESTER**	**6th**
COURSE TITLE	MAGNETIC MATERIALS		
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**
		5	**5**
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).			
COURSE TYPE	SPECIAL BACKGROUND		
PREREQUISITE COURSES:	QUANTUM THEORY OF MATER (EMY-201)		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES		
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy347/		

(2) LEARNING OUTCOMES

Learning outcomes

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

Consult Appendix A

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

At the end of the course, students are expected:

1. To familiarize themselves with the fundamental principles of magnetism
2. To know very well the methodology of solving problems related to magnetic materials.
3. To be able to use this knowledge to solve physical problems.

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

General Competences

- Strengthen the theoretical background to understand fundamental principles of Magnetism.
- Develop critical thinking in solving problems in Magnetism and Magnetic Materials
- Promoting creative and inductive thinking

(3) SYLLABUS

- Magnetic moment, Magnetization, Special Magnetization, Magnetic susceptibility
- Diamagnetism
- Paramagnetism: Classical and a Quantum theory
- Currie and Currie-Weiss laws
- Langevin and Brillouin functions
- Ferromagnetism, classical and quantum theory
- Law of corresponding States
- Weiss areas, Magnetic Anisotropy
- Soft and hard Magnetic Materials
- Anti-ferromagnetism
- Low dimensional interactions, Spin glass, super-paramagnetism
- Magnetization and thermodynamic properties
- Magnetoresistance and Giant Magnetoresistance

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-Face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY	Traditional classroom teaching and problem solving with student's participation.
TEACHING METHODS *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*	
STUDENT PERFORMANCE EVALUATION	Students are evaluated in Greek as follows: c. Optional mid-term exam (30%) d. Final examination (70%) that includes: - Theory. Understanding of basic principles is examined. - Solve problems that promote their critical and creative thinking. Students have the right to see their exam and ask questions.

Activity	*Semester workload*
Lectures	52
Exercises in the class	13
Homework	60
Course total	**125**

(5) ATTACHED BIBLIOGRAPHY

- B.D. Cullity and C.D. Graham, "Introduction to Magnetic Materials", 2nd edition, Willey, and IEEE.
- Notes from the instructor on the course's website.
- David Jiles, "Introduction to Magnetism and magnetic Materials", 2nd edition, Chapman & Hall (1998)

EMY - 348 Mechanics of Materials Laboratory

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING

ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING			
LEVEL OF STUDIES	UNDERGRADUATE			
COURSE CODE	**EMY-348**	**SEMESTER**	**6**	
COURSE TITLE	Mechanics of Materials Laboratory			
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 and exercises		2+5	8
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).				
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	General background			
PREREQUISITE COURSES:	EMY342			
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK			
IS THE COURSE OFFERED TO ERASMUS STUDENTS	NO			
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy348/			

(2) LEARNING OUTCOMES

Learning outcomes

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

Consult Appendix A

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

The knowledge which the students will acquire upon successful completion of the course comprises:

• the mechanical properties of various materials via the basic engineering test methods.
• the basic elements of semiconductor physics and technology (conductivity, carrier type, types of dopants, thermal diffusion doping) and of semiconductor diodes
• the basic aspects and use of high dielectric permittivity materials, fabrication of powders and pellets using liquid chemistry followed by high-temperature calcination, structural characterization by X-Ray diffractometry and dielectric assessment by impedance spectroscopy and its thermal dependence
• skills for mastering experimental techniques which are widely used in solid-state materials science and technology
• choosing right instruments or modules for the implementation of an experimental setup in materials science, making correct interconnections between them with/or without the aid of a control computer, finding the useful range of instrument/module functionality for each specific experimental need
• conducting experimental measurements, in-situ assessing of their reliability based on known material properties
• assessment of the experimental results by i) verifying (or not) the expected material, ii) studying of its known properties with assessment of material quality always within the range of trust imposed by experimental error and iii) proposing ways to remedy or bypass methodology drawbacks in future attempts to run the same fabrication and/or characterization experiments, as a way to improve the quality of materials and the accuracy of the experimental results

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and

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

(3) SYLLABUS

1. Mechanical properties of metals and polymeric materials. Mechanical properties of solid materials under tension: elastic, inelastic and plastic deformation. Stress-strain curves and determination of their final mechanical properties. Determination of viscoelastic properties (bode plot).

2. Introduction to the fine element analysis method. Use of finite element software to solve elasticity equations and calculate stresses, modes of displacements of components and objects. Definition of carrier geometry, definition of materials, definition of loads, mesh generation and numerical solution of the model.

3. Visualization of stress concentration and gradient through photoelasticity. Study of the stress profiles of the materials/samples under investigation with circular polarimetry.

4. Measurement and analytic calculation of deflections in beam bending. Utilize an experimental apparatus to study stresses and deformations in beams under bending loads

5. Doping of a semiconductor with thermal diffusion doping. Introduction to ellipsometry: thickness measurements of the thin thermal oxide layer on silicon.

6. Preparation of an insulator with the Pechini method. Dielectric materials. Dielectric polarization and dependence of permittivity on frequency and temperatures. Structural properties and Curie (temperature) phase transition.

7. Sputtering and thin-film deposition. Townsend relation-Paschen curve. Plasma creation. Ion-collision stimulated sublimation of a metal target. Need of the 'magnetron'. Arrival of atoms, adsorption, clustering and nucleation, 2D (Frank-Van der Merwe) and 3D (Volmer-Weber) growth of thin films. Study of the dependence of thin-film growth rate on chamber pressure and operating ion current. Resistivity measurements (4pt probe technique) on thin metal films and dependence on the growth rate.

8. Electrical characterization of doped semiconductors: case study on silicon. Ellipsometric measurement of thermal oxide thickness and chemical etching of the oxide. Paint and fire technique for making metal contacts on silicon. Van der Pauw measurement of conductivity. Hall measurement of carrier type an mobility. Acquiring a dark current-voltage curve of a silicon diode. Measurement of ideality factor.

9. Structural and dielectric characterization of an insulator. Basic principles of X-Ray diffraction on single crystals and polycrystalline materials: Bragg notation and Laue equations, crystallite size and distortion effects. Introduction in the Lock-In amplification technique,

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face

USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	The introductory lectures are given as computer-based slide-show presentations. All laboratory setups require human-instrument interaction through a computer graphical user interface. Students are encouraged to communicate with the teachers by e-mail for all matters having to do with the course. All announcements, the lab manual, the course regulations and complementary reading material are posted in the course electronic class. The students are encouraged to write lab reports with a computer.
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*	
STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	The course teaching and student evaluation regulations are permanently posted in the course webpage. The course grade comprises three separate evaluation procedures: a) grade of the written progress test. The purpose of the test is to show the level of knowledge of the basic material properties and of the theoretical background and practical implementation of basic experimental materials' characterization techniques. The students are introduced to the above during the lectures after which the test is taken. b) evaluation of each written lab report which is separate for each lab exercise and is prepared by all the members of the team that conducted the experiment. The factors taken into account for evaluating the report are i)completeness, ii) proper processing of experimental data and accurate determination of the values of desired material quantities and their errors and iii) critical assessment of the integrity and level of trust of the final results c) the grade of the final written examination which is based on correctly utilizing and analyzing experimental data given by the examiner for answering to identical or similar problems as those encountered during the course.

Activity	***Semester workload***
Introductory Lectures	18
9 Laboratory exercises	45
Study before the laboratory exercises	18
Writing the 9 laboratory repots	45
Homework and Study for the Final written exam	71
Final Exam	3
Course total	**200**

(5) ATTACHED BIBLIOGRAPHY

- "Εργαστήριο Μηχανικής Υλικών", Πανεπιστήμιο Κρήτης, Ηράκλειο 2023
-Νικόλας Αράβας, Μηχανική των Υλικών (2η έκδοση), Εκδόσεις Τζιόλα, 2023
-Beer-Johnston-Dewolf-Mazurec, Μηχανική των Υλικών (2η έκδοση), Εκδόσεις Τζιόλα, 2010
- Callister William D. "Επιστήμη και Τεχνολογία Υλικών", 9η Έκδοση, Εκδόσεις Τζιόλα, 2016
- C. Kittel "Εισαγωγή στη Φυσική Στερεάς Κατάστασης", Εκδόσεις Πνευματικός, 1979
- D. L. Smith "Thin-Film Deposition" McGraw-Hill, Boston, 1995
- S. M. Sze "Physics and Technology of Semiconductor Devices" Wiley, New York, 1981
- M. Barsoum "Fundamentals of ceramics", Mc Graw-Hill, 1997

EMY - 349 Chemical and Physical Processes

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**EMY-349**	**SEMESTER**	**6th**
COURSE TITLE	Chemical and Physical Processes		

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 and exercises	3+1	6
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	general background
PREREQUISITE COURSES:	
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy349/

(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*

- Comprehension of the fundamental parameters related to physical and chemical processes.
- Ability to state the main differences among the discussed processes.
- Quantitative description of the working principles of the discussed process and the operating principles of related devices, process units or production units.
- Ability to calculate balances (mass, momentum, heat) along the steps of the process.
- Ability to evaluate the efficiency and appropriateness of a production process for a certain application.

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

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…*
	…….

• Promote free, creative and inductive thinking.
• Apply concepts in component design.

(3) SYLLABUS

1. Basic description of physical and chemical processes for the material production and processing.
2. Mostly review with notes and additions relevant to processing: thermodynamic phase equilibria, chemical balances, stoichiometry. Review of basic principles of momentum-energy-mass transfer, and basic principles of mixing (mechanisms of mixing, dispersions, emulsions).
3. Kinetics of chemical reactions: reaction rates, reactions of zero-, first- and second-order reactions, multiple reactions, reaction yield, desired-undesired products, reaction selectivity
4. Chemical reactors: single-phase, two-phase, multi-phase, batch reactor, continuous reactor, semi-batch reactor, plug-flow reactor, continuous stirred-tank reactor, combinations thereof.
5. Adsorption and desorption: equilibria, isotherms, interphase mass transfer, hysteresis.
6. Permeation through membranes, selective permeability, filtration.
7. Extraction and filtration in liquid phase (solvent extraction, solid-liquid extraction): equilibria, mechanisms, solvent types and selection, continuous extraction.
8. Boiling, evaporation, condensation and distillation: principles, operation under controlled temperature or pressure, distillation columns.
9. Drying and desiccation: phenomenology, mechanisms, types of desiccators.
10. Sedimentation and centrifugation: mechanism of action and application to separation processes.
11. Advanced topics: selective separation, gas/solid, liquid/solid and fluidized beds, process combinations, energy considerations, methodology of process design, process design with pumps, heat exchangers

(4) TEACHING and LEARNING METHODS - EVALUATION

<table>
<tr><td>DELIVERY
Face-to-face, Distance learning, etc.</td><td>Face-to-face</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
Use of ICT in teaching, laboratory education, communication with students</td><td>Use of PowerPoint and whiteboard</td></tr>
<tr><td>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</td><td>
<table>
<tr><th>Activity</th><th>Semester workload</th></tr>
<tr><td>Lectures</td><td>39</td></tr>
<tr><td>Tutorials</td><td>13</td></tr>
<tr><td>Study and analysis of bibliography</td><td>98</td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td>Course total</td><td>150</td></tr>
</table>
</td></tr>
<tr><td>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.</td><td>Mid-term exam (elective, 40% of final grade)
Homework problems (elective)
Final exam (mandatory, 60% or 100% if mid-term is not taken)</td></tr>
</table>

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- Tutor Notes
- Βασικές Διεργασίες Χημικής Μηχανικής, 7η Έκδοση, Συγγραφείς: McCabe-Smith-Harriott, 7η έκδοση, 2015, Εκδόσεις Τζίολα,
- Φυσικές διεργασίες, Γεντεκάκης, εκδ. Κλειδάριθμος, 2010
- Μηχανική χημικών διεργασιών, Levenspiel (μεταφρ. Φ. Πομώνγς), εκδ. Κωσταράκη, 2011
- Ανάλυση Χημικών διεργασιών, Κούκος, εκδ. Τζιόλα 2018

SEVENTH SEMESTER

Courses of Elective Direction

EIGHTH SEMESTER

Courses of Elective Direction

EMY - 440 Undergraduate Thesis

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**EMY-440**	**SEMESTER**	**7th and 8th**
COURSE TITLE	UNDERGRADUATE THESIS		
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**
			12
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).			
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	GENERAL BACKGROUND & SKILLS DEVELOPMENT		
PREREQUISITE COURSES:	-		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek and English		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES		
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/proptychiaka/organosi-spoudon/		

(2) LEARNING OUTCOMES

Learning outcomes
The learning goals that students are expected to attain are the following:

- Gain experience in research methodology and in the analysis and writing of scientific results according to rules generally accepted by the scientific community.
- In-depth study of a specific subject of Materials Science and Engineering (preparation, properties, use and technological applications)
- Participation in research processes based on international bibliography
- Enrichment of knowledge and analytical skills.

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6 (comprehensive, specialised, factual and theoretical knowledge within a field of work or study and an awareness of the boundaries of that knowledge).

General Competences

- Development of critical thinking and a sense of cooperation
- Gain of experience in the search and analysis of data and information, using the necessary technologies.
- Independent research
- Planning and task management

(3) SYLLABUS

During the thesis, the student works on a specific topic agreed upon with the supervising professor, provides information, on a regular basis, on his/her progress to the team to which he/she belongs, analyzes any theoretical or experimental data collected, writes a thesis and finally presents it orally before an audience that includes the appointed two-member committee which acts as the examination board.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY	Face-to-Face & Distance Learning (Asynchronous via Edmodo)
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY	Use of powerPoint and whiteboard, Supportive learning through teleconference tools, googledocs, google forms , edmodo, socrative, kahoot ,googleslides, edpuzzle
TEACHING METHODS	***Activity Semester workload*** Bibliography survey 60 hours Experimental Research 120 hours Data analysis 40 hours Workshops 20 hours Writing of Thesis 40 hours Presentation of Thesis 20 hours **Course total** **300 hours**

STUDENT PERFORMANCE EVALUATION	Students are evaluated by: Writing of Thesis 80% Oral presentation and examination 20%

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

1. According to the topic of the thesis

- Related academic journals:

Suggested for presentations:

List of Courses of Elective Direction

Materials Physics and Computational Materials Science

EMY - 401 Optics and Waves

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING			
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING			
LEVEL OF STUDIES	UNDERGRADUATE			
COURSE CODE	**EMY-401**	**SEMESTER**	**8^{h}**	
COURSE TITLE	Optics and Waves			
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**
			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*	Special background			
PREREQUISITE COURSES:	Physics II (EMY-102), Mathematics II (EMY-112)			
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek			
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES			
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy401/ https://teleclass.materials.uoc.gr/courses/SEM6101/			

(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*

- To **get acquainted** with the basic principles of Wave and Optics.
- To **know** the basic principles of Electromagnetism as well as their application in Optics and in the Geometric Optics approximation
- To **know** the basic operation principles of optical systems.

- To **solve** problems related to light propagation through complex optical systems.
- To **become familiar** with the phenomenon of optical anisotropy.
- To **know** the basic principles that govern the wave propagation as well as the phenomena of interference and diffraction.
- To **know** the description of the polarization the transverse waves
- To **solve** problems related to light propagation through polarized optical systems

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

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…*
	…….

- To understand the basic principles of wave propagation.
- To be able to analytically describe transverse waves, that propagate at an arbitrary direction, in any medium, for any polarization.
- To be able to identify wave phenomena in nature.
- To be able to describe both qualitatively and quantitatively the behavior of an optical system.
- To be able to select and effectively use optical metrology techniques.
- To use international literature to be informed about matters of Optics and Photonics.

(3) SYLLABUS

10. **Introduction**,
    Waves in nature, Longitudinal and transverse waves, Wave propagation, Huygens-Fresnel principle,
11. **Electromagnetism**,
    Maxwell equations, Geometrical Optics,
12. **Imaging,**
    Fermat's principle Snell law, Lenses and Mirrors, Optical Aberrations, Basic principles of Optical engineering,
13. S**ources and detectors of optical radiation**,
    Black body radiation, diodes, Lasers, Photometry, Photomultipliers, Photodiodes, CCD sensors.
14. **Color**
    Visible spectrum, spectral colors, color vision and perception, colorimetry and color spaces
15. **Polarization**,
    Jones and Stokes representation, Optical anisotropy and Dichroism,
16. **Wave superposition - Interference**,
    Beats, optical wavepackets, group velocity, interference fringes, Interferometers and Optical metrology,
17. **Diffraction**,

Fresnel and Fresnel-Kirchhoff diffraction integrals, Fraunhofer diffraction, diffraction from various apertures, resolution of optical systems

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face to face lectures

USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
Use of ICT in teaching, laboratory education, communication with students
	• Use of slides
	• Videos with demonstration/understanding experiments.
	• Demonstration experiments of basic optical phenomena
	• Open and free educational material available through the eClass webpage (Creative Commons CC-BY-ND-3.0, licenses) of the following:
	  o Lecture slides
	  o Solved and unsolved exercises
	  o Simulations and animations with the use of open source software
	  o Video-recorded lectures
	• Furthermore in the eClass webpage the students can find:
	  o Selected previous exams
	  o Sets of self evaluation tests (quiz) with automated grading and comments
	  o Bibliography
	• Communication through email and constant office hours available through the class webpage.
	• Optional student projects are monitored through eClass platform

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	52
Projects	20
Directed learning activity (office hours)	10
Non-directed learning activity	50
Course total	**132**

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.*	Language: Greek Evaluation Methods: Final written exams (100%) or participate in projects: 20% Presentation, 80% final written exams. Participation in Projects is optional. The grade is auxiliary to the percentage mentioned above. The presentation deals with a topic in the wider area of optics and lasts 10 minutes. The evaluation criteria are accessible on the class webpage.

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

"Topics in Optics", E. Hecht, translated in Greek as "Οπτική" from I. Spyridelis, Schaum's Outline Series.

"Optics", E. Hecht, Addison-Wesley, (2001).

"Introduction to Modern Optics", G.R. Fowles, Dover, (1989).

"Principles of Optics", M. Born, E. Wolf.

"Introduction to Fourier Optics", J. W. Goodman, McGraw-Hill, (1996).

- Related academic journals:

EMY - 402 Matter and Light

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**EMY-402**	**SEMESTER**	**8th**
COURSE TITLE	Matter and Light		
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**
Credits awarded for the whole course (lectures and practice)		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*	General background		
PREREQUISITE COURSES:	Quantum Theory of Matter (EMY-201)		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes		
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy402/		

(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 at the end of the course:

- They will possess advanced knowledge and skills (critical understanding of theories and principles) in the field of modern quantum mechanics with emphasis on the structure of matter and its interaction with electromagnetic radiation.
- They will be able to use the knowledge they acquired in a way that shows a professional approach to their work.
- They will be able to gather and interpret elements of the subject to form scientifically documented opinion, both on scientific and social/ethical issues. (e.g. risks of new technologies to human health).
- They will be able to communicate information and solutions to the subject of the course (structure of matter and interaction with electromagnetic radiation) to both a specialized and non-specialized audience.
- They will have developed those knowledge-acquiring skills, which they need to pursue further studies with a high degree of autonomy.

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

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…*
	…….

- *Work independently and in Teamwork.*
- *Analytical and synthetic ability to solve problems.*
- *Critical thinking.*
- *Manages complex physical theories and mathematical techniques.*

The above is achieved by seeking answers to problems with different degrees of difficulty and need for synthetic ability. Students are invited to work either autonomously or collectively, both in the classroom and through homework.

(3) SYLLABUS

- Mathematical foundations of quantum mechanics, Hermitian operators, Eigenvalues, continuous and discrete spectrum. Conservation laws.
- Dirac formalism, Harmonic oscillator, Angular momentum, Spin, synthesis of spins.
- Atoms, solids, band structure
- Time-Dependent Problems, Approximation Techniques in Time-Dependent Problems. Laser radiation and interaction with matter.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of ICT in delivery and communication with students
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*	
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.*	Language: Greek Evaluation methods: Problem solving, Short-answer questions Grading scheme: Active participation in the class 10%, Homework 20%, Exam 70% Or Final Exam 100%

Activity	***Semester workload***
Lectures	39
Practice	13
Homework assignments	20
Homework study	60
Course total	**132**

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- *S. Trachanas. Quantum Mechanics, vol. II (New Edition), Crete University Press (2008).*
- *A. Messiah, Quantum Mechanics, Dover (1999).*
- *R. Shankar, Principles of Quantum Mecahnics, Plenum Press (1994).*
- *E. Merzbacher, Quantum Mechanics, John Wiley & Sons, 3rd Edition (1998).*
- *J. Sakurai, Modern Quantum Mechanics, Addison Wesley (1994).*

- Related academic journals:

EMY - 403 Solid State Physics II: Electronic And Magnetic Properties

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING

ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	EMY-403	**SEMESTER**	8th
COURSE TITLE	SOLID STATE PHYSICS II: ELECTRONIC AND MAGNETIC PROPERTIES		

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	
Practice	1	
Office hours	2	
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).	4	5

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	SPECIAL BACKGROUND, SKILLS DEVELOPMENT, SPECIALIZED GENERAL KNOWLEDGE
PREREQUISITE COURSES:	QUANTUM THEORY OF MATTER (EMY-201)
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy403/ http://theory.materials.uoc.gr/courses/fsklI/

(2) LEARNING OUTCOMES

Learning outcomes

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

Consult Appendix A

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

By the end of the course, students are expected to:

1. Understand the relationship between the atomic and electronic structure of solid materials with their macroscopic properties as well as with the properties that render them invaluable in modern technology.
2. Know the general relation between atomic configuration and electronic structure (electronic energy states, bands and gaps), how this determines conductors, semiconductors and insulators, the interaction of materials with the electromagnetic field.
3. Understand the basics of quantum theory of solids required for electrical properties description.
4. Become familiar with the most important aspects of the electronic, optical, magnetic properties of materials so that they can understand the design and operation of electronic and magnetic devices in more specialized courses.

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

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*
	Respect for the natural environment

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

- Production of free, creative and inductive thinking
- Working independently
- Search for, analysis and synthesis of data and information, with the use of the necessary technology

(3) SYLLABUS

14. Fundamental concepts in solid state physics: from atoms to solids

- Equilibrium states at minimum energy: Coulomb potential energy - quantum kinetic energy.
- Heisenberg's uncertainty principle and minimum kinetic energy, Pauli's exclusion principle.
- Size and energy of atoms.
- Formation of molecules and solids.
- Estimation of basic quantities and properties of solids from simple fundamental principles and dimensional analysis.
- Short review of atomic structure, bonding, crystal lattices, and properties of solids.
- Ion motion - small oscillations.

15. Electronic, electrical, and optical properties of solids

- The problem of electrical resistivity and conductivity, classical Drude formula.
- Adiabatic (Born-Oppenheimer), independent particle, harmonic approximation.
- Periodicity, Bloch theorem, origin of energy bands and gaps, metals, insulators, and semiconductors.
- One-dimensional "crystals", chain of classical coupled harmonic oscillators and phonon bands.
- Linear combination of atomic orbitals, from diatomic molecule to one-dimensional tight-binding model, analogy with coupled harmonic oscillators, bands and gaps for more than one orbital per atom, diatomic unit cell.
- Electrons in a conduction band, free electron model, Fermi energy, total (kinetic) energy, density of states, semiclassical theory of conduction in metals, dc conductivity.
- Conduction in semiconductors, electrons and holes, carrier effective mass, mobility and concentration, temperature dependence, chemical potential and Fermi energy.
- Extrinsic conductivity in semiconductors, impurities, donors, acceptors, Fermi level position in extrinsic semiconductors, temperature dependence, carrier lifetime.
- Materials response to EM field, dielectric function, oscillators model for conductivity and dielectric function, properties and uses of dielectric function.

16. Magnetic properties of solids

- Macroscopic properties and atomic origin of magnetic moments, orbital angular momentum and spin, magnetic moment of an atom or ion, Hund's rules.
- Diamagnetic, paramagnetic, ferromagnetic, antiferromagnetic and ferrimagnetic materials.
- Diamagnetic susceptibility (Langevin).
- Paramagnetic susceptibility of solids, Curie's law, paramagnetic susceptibility of conduction electrons.
- Mean-field approach to ferromagnetism, Curie-Weiss law.
- Antiferromagnetism, ferromagnetism.

17. Superconductivity

- Introduction, macroscopic description and phenomenology of superconductivity.
- Superconducting materials and critical temperatures.
- Electrical resistance zeroing.
- Magnetic field exclusion inside a superconductor (Meissner effect).
- Critical magnetic field as a function of temperature.
- Elements of microscopic theory of superconductivity (BCS).
- London equation.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of ICT for communication with students who are encouraged to search for online resources for better understanding material taught in class and for lecture presentations.
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 — 39 Exercises — 13 Study hours — 73 Course total — **125**
STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	Student performance evaluation consists of an optional midterm exam and a mandatory final exam in Greek that includes developing questions and problem solving. Students have the right to view their exam scripts after the grading results and to ask questions.

(5) ATTACHED BIBLIOGRAPHY

• E.N. Economou, Solid State Physics, Volume I, Metals, Semiconductors, Insulators, Crete University Press, Heraklion (1997).
• C. Kittel, Introduction to Solid State Physics, 5th Edition, Greek translation, Pneumatikos Editions, Athens (1979).
• E.N. Economou, Solid State Physics, Volume II, Order, Disorder, Correlations, Crete University Press, Heraklion (2003).
• S. Trachanas, Quantum Mechanics I: Fundamental Principles, Simple Systems, Structure of Matter. A Basic Introduction for Physicists, Chemists and Engineers, Crete University Press, Heraklion (2005).
• W.D. Callister, Jr., Materials Science and Engineering, 5th Edition, Greek translation, Tziola Editions, Thessaloniki (2004).
• I. Harald, L. Hans, Solid-State Physics. An Introduction to Principles of Materials Science, Greek Translation, Ziti Editions, Thessaloniki (2012).
• P. Robert, Electrical and Magnetic Properties of Materials, Artech House, Norwood MA (1988).

• W.A. Harrison, Electronic Structure and the Properties of Solids: The Physics of the Chemical Bond, Dover, New York (1989).
• R.C. O' Handley, Modern Magnetic Materials: Principles and Applications, Wiley (2000).

EMY - 404 Semiconductor Optoelectronics

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**EMY-404**	**SEMESTER**	**7th**
COURSE TITLE	SEMICONDUCTOR OPTOELECTRONICS		
INDEPENDENT TEACHING ACTIVITIES		**WEEKLY TEACHING HOURS**	**CREDITS**
		3	5
COURSE TYPE	SPECIALIZED GENERAL KNOWLEDGE		
PREREQUISITE COURSES:	Microelectronic Materials (EMY-346)		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES (reading course)		
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy404/		

(2) LEARNING OUTCOMES

Learning outcomes
The course includes the study of Semiconductor Physics as well as of the operating principles of basic optoelectronic devices. The learning goals that students should have achieved at the end of the course are the following: 1. Enhanced basic understanding of semiconductor physics. 2. Understanding important optoelectronic devices such as the semiconductor diode laser and solar cell. 3. Preparation of the students for attending postgraduate level classes in the field of semiconductors and optoelectronics. *The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.*

- Search for, analysis and synthesis of data and information, with the use of the necessary technology
- Production of free, but structured, creative and inductive thinking
- Working independently

(3) SYLLABUS

1. Energy bands in semiconductors
2. Carrier statistics in 3- and 2-Dimensions
3. Carrier transport, P-N diode
4. Optical transitions in semiconductors
5. Quantum wells
6. LEDs, detectors
7. Optical gain – Laser action
8. Waveguides
9. Solar cells

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY.	Face-to-Face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY	Use of teleclass for communication and for uploading material related to the lectures. Use of Power Point during lectures. Use of multimedia (videos) and scientific web resources to display additional information whenever required.
TEACHING METHODS	
STUDENT PERFORMANCE EVALUATION	Students have the choice to be evaluated by one of the following methods: the first involves a combination of graded homework, a presentation in the class and a final written exam on all material. The second involves the homework and the final exam, while the third is just taking the final exam. The exams are in Greek and typically involve the solution of 3 to 4 problems of semiconductor physics and devices. Students have the right to view their exam scripts after the grading results are published and ask questions.

Activity	*Semester workload*
Lectures	39
Study at home. Problem solving and theory reading	86
Course total	**125**

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- J. Singh, "Οπτοηλεκτρονική", Εκδόσεις Τζιόλα, 2016
- S.O. Kasap, Αρχές Ηλεκτρονικών Υλικών και Διατάξεων, Παπασωτηρίου 2004 Αθήνα
- B.G. Streetman and S. Banerjee, Solid State Electronic Devices, Prentice Hall, (2000)
- R. F. Pierret, Semiconductor Device Fundamentals, Pearson (1996)
- S. M. Sze, Physics of Semiconductor Devices, Wiley, New York (1981)
- D. Wood, Semiconductor Optoelectronic Devices, Prentice-Hall, UK (1994)

EMY - 405 Nanomagnetic Materials and Applications

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	EMY-405	**SEMESTER**	8th
COURSE TITLE	NANOMAGNETIC MATERIALS AND APPLICATIONS		

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**
	3	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*	SPECIAL BACKGROUND
PREREQUISITE COURSES:	MAGNETIC MATERIALS (EMY-347)
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy405/

(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*

- This course will provide students with the fundamental knowledge in the field of nanomagnetic materials and their applications. At the end of the course the student will be able

  - to understand the basic concepts of applied magnetism
  - understand and provide explanation for the basic properties of hard and soft magnetic materials.
  - to propose methods for characterization of different magnetic materials
  - to discuss various applications of nanomagnetic materials in cutting edge technologies and devices.
  - to have acquired experience in collecting information on special topics of micro/nanomagnetism and be in position to conduct research in the field.

  -

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

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…*
	…….

- Development of interdisciplinary and critical thinking
- Search for, analysis and synthesis of data and information, with the use of the necessary technology
- Production of free, creative and inductive thinking

(3) SYLLABUS

- Magnetostatics
- Classification of ferromagnetic materials
- Magnetic measurements and characterization
- Types of magnetic order- Magnetic domains
- Ferromagnetic nanoparticles
- Thin magnetic films
- Nanostructured permanent magnets
- Nanomagnetic materials for information storage
- Giant magnetoresistance

(4) TEACHING and LEARNING METHODS – EVALUATION

<table>
<tr><td>DELIVERY
Face-to-face, Distance learning, etc.</td><td>Face-to-face</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
Use of ICT in teaching, laboratory education, communication with students</td><td>Supportive learning through the active web site of the course in the learning platform of the University of Crete (teleclass.uoc.gr).</td></tr>
<tr><td>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</td><td>
<table>
<tr><th>Activity</th><th>Semester workload</th></tr>
<tr><td>Lectures</td><td>26</td></tr>
<tr><td>Tutorials</td><td>13</td></tr>
<tr><td>Project-essay writing</td><td>30</td></tr>
<tr><td>Homework</td><td>81</td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td>Course total</td><td>150</td></tr>
</table>
</td></tr>
<tr><td>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.</td><td>The evaluation process described in the course website includes

• An optional test
• A written report on a project selected by the student from a list.
• A final written examination that includes a combination of
- Short-answer questions
- Problem solving
- Theory questions requiring a topic development
Students retain the right to view their exam scripts after grades are published and ask questions.</td></tr>
</table>

(5) ATTACHED BIBLIOGRAPHY

- *Suggested bibliography:*

Notes are provided by the lecturer (in the Greek language) on the course website that cover the course in its entirety. The following books can be used for reference to specific topics.

1. J.M.D. Coey, “Magnetism and Magnetic Materials”, Cambridge Univ. Press, Greek translation: Public City (2012).
2. D. Jiles, “Introduction to Magnetism and Magnetic Materials”, Chapman & Hall (1991).
3. S. Chikajumi, “Physics of magnetism” , Krieger (1978).
4. C. Kittel, “Introduction to Solid State Physics”, Wiley, Greek translation: Pnevmatikos Publishing (1976).

- Related academic journals:

Journal of magnetism and magnetic materials

EMY - 406 Biophotonics Engineering

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**EMY-406**	**SEMESTER**	**7th**
COURSE TITLE	Biophotonics Engineering		

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**
Credits awarded for the whole course (lectures and practice)	3	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*	Special background Elective Course
PREREQUISITE COURSES:	Quantum Theory of Matter (EMY-201)
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek / English
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy406/

(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*

Level 6.

Students at the end of the course are expected:

- To understand the physics of the interaction of light with biomaterials across the electromagnetic spectrum.
- To be able to scientifically justify the use of specific light sources and lasers in Biology and Medicine.
- To be able to suggest scientifically sound photonics solutions for the treatment, spectroscopic analysis, and imaging of biomaterials.
- To have acquired the knowledge, and developed the skills needed for pursuing further studies in the field.

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…*
	…….

- *Work independently and in Teamwork.*
- *Analytical and synthetic ability to solve problems.*
- *Critical thinking.*
- *Manages complex physical theories and mathematical techniques.*
- *Bibliographic research, analysis, synthesis and presentation of contemporary research findings.*

The above is achieved by seeking answers to problems with different degrees of difficulty and need for synthetic ability. Students are invited to work either autonomously or collectively, both in the classroom and through homework.

(3) SYLLABUS

- Properties of light; linear and nonlinear
- Light sources and detectors
- Physics of the light-biomatter interaction
- Bio-imaging and spectroscopy (liner and nonlinear microscopy techniques, NSOM, FRET, OCT, Photo-acoustic, MRI)
- Optical bio-sensors – fiber devices – endoscopes
- Biomedical treatments with light
- Portable and wearable monitoring and treatment devices

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of ICT in delivery and communication with students
TEACHING METHODS *The manner and methods of teaching are described in detail.* *Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.*	

Activity	***Semester workload***
Lectures	40
Study at home	60
Homework/presentations	25

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		
	Course total	***120***
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.*	Language: Greek / English Evaluation methods: Problem solving, Short-answer questions Grading scheme: • Active participation in the class (short quizzes) 10%, Homework/presentations 20%, Final Exam 70% • Alternatively: Final Exam 100%	

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- *Biophotonics – Concepts to Applications, G. Keiser, Springer*
- *Ultrafast Biophotonics, P. Vasa, D. Mathur, Springer*
- *Handbook of Biophotonics, Popp J., Tuchin V.V., Chiou A., Heinemann S.H. (Eds.), Wiley*
- *Understanding Biophotonics, K. K. Tsia (Ed.), Pan Stanford Publishing*

EMY - 407 Polymer Physics

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING			
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING			
LEVEL OF STUDIES	UNDERGRADUATE			
COURSE CODE	**EMY-407**	**SEMESTER**	**8th**	
COURSE TITLE	POLYMER PHYSICS			
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**
			3	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*	SPECIALZED GENERAL KNOWLEDGE			
PREREQUISITE COURSES:	EMY-242			
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK			
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES			

COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy407/

(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*

Detailed discussion of basic properties of polymers, statics and dynamics. The course assumes elementary knowledge on the topic. The full list of topics is shown below but not all are covered. After the discussion of statics and elements of macromolecular motion, some special topics are covered depending on the interests of students.

The learning goals of the course are:

- 1. Familiarization of students with basic parameters and scaling theories of polymers.
- 2. Analysis of polymer properties, comparison of theoretical predictions and experimental measurements
- 3. Understanding the multiple length and time scales of polymers.
- 4. Acquire a grasp of the use and applications of polymers.
- *The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.*

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…*
	…….

- Development of analytical, interdisciplinary and critical thinking
- Develop methodology for the simplification and solution of difficult problems with practical significance
- Production of free, creative and inductive thinking

(3) SYLLABUS

Macromolecules and macromolecular quantities. Polymer specificity. Self-similarity.
Macromolecules length and time scales. Characteristics of glasses, crystals, networks, melt.
Ideal chains: Statistics of Polymer Chains. Polymer Chain and network Elasticity
Real chains: Sizes and elasticity. Solvent Quality.
Polymer blends and solutions. Phase diagrams
Macromolecular motions, coarse-graining, Viscoelasticity and Diffusion
Dynamics of Unentangled Chains (Rouse and Zimm models), Predictions for Rheology and Diffusion
Dynamic Light Scattering, Dynamic Structure Factor
Dynamic Mechanical Spectroscopy and Time-Temperature Superposition
Entangled Chains-Entanglements: Reptation and the deGennes-Doi-Edwards model and corrections.
Special topics (selection, depending on the progress and interest of the students): dynamics of branched polymers, polyelectrolytes, supramolecular polymers, copolymers, gels, network models. Industrial polymers, polymer processing technologies in industry, physical properties of polymers, additives that change the properties of plastic products, recycling of plastics.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-Face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	
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*	
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.*	Students are evaluated with homework problems, project, presence in class and response to questions, and final exam in Greek which involves solution of problems. Oral examination is offered to students with learning disabilities. Students have the right to see their exam after the grades are announced and ask questions. The course evaluation is discussed during the first class and posted on the web.

Activity	***Semester workload***
Lectures	25
Exercises	14
Homework and visits of industrial sites (optional)	86
Course total	**125**

(5) ATTACHED BIBLIOGRAPHY

- *Suggested bibliography:*

Instructor's notes (on the web, in Greek)
M. Rubinstein, R. H. Colby, Polymer Physics, Oxford, NY, 2003.
G. Strobl, The physics of polymers, Springer, NY, 1997.
M. Doi, Introduction to polymer physics, Oxford, NY, 1995.

- *Related academic journals:*

Macromolecules
Soft Matter
Polymer
ACS Macro Letters
Journal of Polymer Science: Polymer Physics

EMY - 408 Physics of Colloidal Dispersions

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING			
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING			
LEVEL OF STUDIES	UNDERGRADUATE			
COURSE CODE	**EMY-408**	**SEMESTER**	**7th**	
COURSE TITLE	Physics of Colloidal Dispersions			
INDEPENDENT TEACHING ACTIVITIES			**WEEKLY TEACHING HOURS**	**CREDITS**
			3	5
COURSE TYPE	ELLECTIVE COURSE			
PREREQUISITE COURSES:	EMY-242			
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK			
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES			
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy408/			

(2) LEARNING OUTCOMES

Learning outcomes
The course is an introduction to colloidal dispersions aiming in providing a basic knowledge on colloidal interactions, phase behavior and colloidal dynamics The learning goals that students should have achieved at the end of the lesson are the following: 1. Familiarize with Colloidal systems and the main physical mechanisms governing their behavior 2. Understand the role of colloidal interactions in the stability of colloidal dispersions and the thermodynamic phase behavior as well as in the formation of out of equilibrium states such as glasses and gels 3. To understand Brownian motion, and the characteristics of diffusion *The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.*
- Development of interdisciplinary and critical thinking - Search for, analysis and synthesis of data and information, with the use of the necessary technology - Production of free, creative and inductive thinking

(3) SYLLABUS

Introduction

7. Introduction
8. Types of colloidal systems
9. Colloidal Interaction, colloidal stabilization
10. Colloid-polymer mixtures
11. Dense suspensions and crystals
12. Colloidal glasses and gels
13. Colloidal Dynamics – Brownian motion

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY.	In Classroom
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY	Use of Power Point and video material from the internet
TEACHING METHODS	***Activity*** / ***Semester workload*** Lectures: 39 Homework: 86 Course total: **125**
STUDENT PERFORMANCE EVALUATION	Students are evaluated by a final written exam in Greek that includes a combination of: - Questions on theory - Exercises including calculations Oral exam is foreseen for students with specific learning difficulties - Students have the right to view their exam scripts after the grading results are published and to ask questions.

(5) ATTACHED BIBLIOGRAPHY

- *Suggested bibliography:*

1. Course notes (G. Petekidis)
2. R. J. Hunter, Foundations of Colloid Science, Oxford, University Press, New York, 2001
3. W.B. Russel, D.A. Saville, W.R.Schowalter, Colloidal Dispersions, Cambridge University Press, 1989
4. Panagiotou, Interfacial phenomena and Colloidal systems 1998.
5. D. F. Evans, H. Wennerström, The Colloidal Domain, Where Physics, Chemistry, Biology and Technology meet, 2nd Edition, John Willey and Sons, New York, 1999.
6. R. M. Fitch, "Polymer Colloids, A comprehensive introduction", Academic Press, London, 1997

- *Related academic journals:*

Soft Matter, Macromolecules, Langmuir, Journal of Colloid and Interface Science, Physical Review Letters, Physical Review E

EMY - 411 Partial Differential Equations

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**EMY-411**	**SEMESTER**	**8th**
COURSE TITLE	PARTIAL DIFFERENTIAL EQUATIONS		

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**
	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*	SPECIALIZED GENERAL KNOWLEDGE, SKILLS DEVELOPMENT
PREREQUISITE COURSES:	EMY-211
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy411/

(2) LEARNING OUTCOMES

Learning outcomes

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

Consult Appendix A

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

The main course objective is to provide a modern education on partial differential equations. The course learning outcomes are as follows :

- Demonstrated knowledge and understanding of the mathematical principles of second order differential equations.
- Advanced ability to apply this knowledge in order to solve realistic problems in materials science and engineering

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

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

Working independently	*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…*
	…….

- Ability to express physical problems on a mathematical basis
- Acquisition of mathematical skills useful in other branches of materials science and engineering
- Development of creative and inductive thinking

(3) SYLLABUS

- Partial differential equations (PDE) by function elimination. General form of 2nd order differential equations. Wave, Laplace and heat equations.
- Method of separation of variables. PDE is three dimensions. Superposition principle. Initial and boundary conditions.
- Sturm-Liouville equation. Eigenvalue problem. Expressing a function as a series of eigenfunctions. Degeneracy. Fourier series. Parseval's theorem.
- PDE in finite domains. 2-dimensional Laplace equation in Cartesian and spherical polar coordinates. Legendre polynomials . 2-dimensional wave equation in polar coordinates. Bessel functions.
- Fourier transforms. Application to the solution of PDE.
- Inhomogeneous PDE's. Green's functions method.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Supportive learning through the active web site of the course in the learning platform of the University of Crete (teleclass.uoc.gr).
TEACHING METHODS *The manner and methods of teaching are described in detail.* *Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.* *The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS*	
STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice*	The evaluation process, as reported on the course website, is carried out in the Greek language by an optional test during the course and a final written examination using a combination of

Activity	***Semester workload***
Lectures	39
Classwork	13
Homework	78
Course total	**130**

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.***	- Short-answer questions - Problem solving Students retain the right to view their exam scripts after grades are published and ask questions.

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography: (in Greek)

1. S. Trahanas, "Partial Differential Equations ", University of Crete Publishing (2001).
2. W.A. Strauss, "Partial Differential Equations", Wiley, National Technical University Publishing (2007).
3. I. Vergados, "Mathematical Methods of Physics I", University of Crete Publishing (2005)
4. I. Vergados, II, "Mathematical Methods of Physics II", Symmetria Publishing, Athens (2004)
5. W.E. Boyce and R.C. DiPrima, D.B. Meade, "Elementary differential equations", Wiley, National Technical University Publishing (1999).

EMY - 412 Introduction to Numerical Analysis

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	EMY-412	**SEMESTER**	8th
COURSE TITLE	Introduction to Numerical Analysis		
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 and programming exercises		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*	Optional, Special background		
PREREQUISITE COURSES:	Introduction to Computer Programming (EMY-113)		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES		
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/EMY412/ https://teleclass.materials.uoc.gr/courses/SEM8125/		

(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*

Upon successful completion of the course, students will
1.know the basic numerical methods for solving computational mathematical problems and will be able to develop complex computer programs in order to implement them.
2. be prepared to attend additional computational courses: Computational Materials Science I (EMY-415) and II (EMY-416) etc.
3. be able to understand and apply new numerical methods to solve complex mathematical and physical problems.

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

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…*
	…….

Solving complex problems
Development of scientific thinking
Use of libraries and multiple bibliographic sources
Search for resources and online lessons
Create notes and standalone study method
Implementation of research work
Manage time and deadlines

(3) SYLLABUS

Numeral systems. IEEE Standards for integer and floating point numbers. Computer representation of numbers.
Numerical solution of a nonlinear equation. Definitions, useful theorems. Methods: bisection, regula falsi, secant, Muller, fixed point, Householder (Newton-Raphson, Halley).
Systems of linear equations. Direct methods (Gauss elimination, Gauss-Jordan, LU). Iterative methods (Gauss-Seidel, Jacobi, SOR). Other methods. Applications: calculation of the determinant of a matrix, inverse matrix, matrix eigenvalues and eigenvectors. Numerical solution of systems of nonlinear equations.
Function/set of points approximation: Interpolation of polynomial, rational, piecewise polynomial, spline. Runge phenomenon. Numerical differentiation.
Least squares approximation: line, polynomial, logarithmic and exponential. Correlation coefficient.
Numerical quadrature. Trapezoid and Simpson rules. Newton-Cotes formulas. Gauss quadrature methods (Legendre, Hermite, Laguerre, Chebyshev). Clenshaw–Curtis method. Other methods.
Numerical solution of initial value problems of first order ordinary differential equations (ODE). Methods: Euler (explicit/implicit), Taylor, Runge-Kutta 2nd and 4th orders. Systems of ODEs. Higher order ODEs.
Other topics (FFT, optimization, etc)

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Computers and projector are used in teaching, exercises and for communicating with students (through the course website and by email).
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: 26 Programming exercises: 26 Independent study: 65 Course total: ***117***
STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	The evaluation is in greek. The exam comprises questions on theory and programming exercises. The evaluation consists of (optional) mid-term and final written exams.

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography (greek):

- Notes (in greek): https://raw.githubusercontent.com/sstamat/mybooks/main/numanal.pdf
- Λ. Πιτσούλης, "Εισαγωγή στην Αριθμητική ανάλυση", έκδοση 2η, Εκδόσεις Τζιόλα. 2015.
- Steven C. Chapra, Raymond P. Canale, "Αριθμητικές Μέθοδοι για Μηχανικούς", έκδοση 7η. Εκδόσεις Τζιόλα. 2016.
- *Ιωάννης Θ. Φαμέλης, "Υπολογιστικά Μαθηματικά", Εκδόσεις Κριτική, 2021*

EMY - 413 Advanced Computer Programming

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	EMY-413	**SEMESTER**	7th

Advanced Computer Programming	*ADVANCED COMPUTER PROGRAMMING*		
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 and programming exercises		4	5
Add rows if necessary. The organization of teaching and the teaching methods used are described in detail at (d).			
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Optional, special background, skills development		
PREREQUISITE COURSES:	Introduction to Computer Programming (EMY-113)		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES		
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy413/		

(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*

Upon successful completion of the course, students will

- have become familiarized with most of the capabilities of the Python language.
- use the basic structures of the Set and the Dictionary.
- know the use of various libraries such as:
    a. NumPy, SciPy (mathematical calculations with arrays)
    b. Matplotlib (diagrams)
    c. Pandas (Data manipulation from files like .csv, .xlsx etc.)
- be able to use the capabilities of Object-Oriented Programming.
- be able to create medium and/or more specialized applications for the processing of experimental data in the context of the laboratory courses, such as fitting an optimal curve to experimental data, creating simple diagrams, etc.
- be prepared to attend the computational courses of the curriculum: Computational Materials Science I and II (EMY-415 / EMY-416), as well as classes that need programming skills.
- have developed a systematic method to tackle a complex problem by analysing it into many, simple, and easy tasks.

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

General Competences

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

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

- Solving complex problems.
- Development of scientific thinking.
- Use of libraries and multiple bibliographic sources.
- Search for resources and online lessons.
- Create notes and standalone study method.
- Manage time and deadlines.

(3) SYLLABUS

- Mutable objects: Dictionaries, Sets
- Principles of Object-Oriented Programming (classes, instances, properties, functions, inheritance)
- Module libraries
- Introduction in Python libraries like:
    a. Numpy, SciPy (n-dimensional arrays, operations with arrays, simple linear algebra problems, multiple regression problems, etc.)
    b. Matplotlib (simple and complex diagrams)
    c. Pandas (Data manipulation from files like .csv, .xlsx etc.)

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Computers and projectors are used in teaching, exercises and for communicating with students (through the course website and by email). The material of the course is posted on the department's asynchronous training platform.
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*	
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*	Students are examined and evaluated in writing during and at the end of the semester.

Activity	***Semester workload***
Lectures	26
Programming exercises	26
Homework	98
Course total	**150**

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

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- Lecturer's notes
- Python Εισαγωγή στους Υπολογιστές (4η αναθεωρημένη έκδοση), 2021, Ν. Αβούρης, Μ. Κουκιάς, Β. Παλιούρας, Κυρ. Σγάρμπας, Πανεπιστημιακές Εκδόσεις Κρήτης
- Το βιβλίο της Python, 2019, Ν. Σαμαράς, Κων/νος Τσιπλίδης, Εκδ. Κριτική, ISBN: 978-960-586-312-8
- Η γλώσσα Python σε βάθος, 2023, Νίκος Χατζηγιαννάκης, Εκδόσεις Κλειδάριθμος, ISBN: 978-960-645-471-4
- A Primer on Scientific Programming with Python (5th edition), Hans Peter Langtangen, Springer, 2016, ISBN 978-3-662-49886-6
- Introduction to Scientific Programming with Python, Joakim Sundnes, SIMULA - Springer Open, 2020, ISBN 978-3-030-50355-0
- Numerical Python: Scientific Computing and Data Science Applications with Numpy, SciPy and Matplotlib (2nd edition), Robert Johansson, Apress, 2019, ISBN 978-1-4842-4245-2
- Python Programming and Numerical Methods A Guide for Engineers and Scientists, Qingkai Kong, Timmy Siauw, Alexandre M. Bayen, Elsevier – Academic Press, 2021, ISBN 978-0-12-819549-9
- Effective Pandas Patterns for Data Manipulation, Matt Harrison, 2021, ISBN 979-8772692936
- Computational Physics (3rd edition), Rubin H. Landau, Manuel J. Páez, Cristian C. Bordeianu, Wiley-VCH, 2010, ISBN 978-3-527-41315-7
- Computational Problems for Physics, Rubin H. Landau, Manuel José Páez, CRC Press, 2018, ISBN 978-1-1387-0541-8

EMY - 414 Laboratory for Computer Control and Automation of Measurement Systems

(1) GENERAL

SCHOOL	Sciences and Engineering		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**EMY-414**	**SEMESTER**	**8th**
COURSE TITLE	Laboratory for Computer Control and Automation of Measurement Systems		

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, laboratory exercises	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*	Skill development	
PREREQUISITE COURSES:	Introduction to programming (EMY-113)	
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek	
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes	
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy414/	

(2) LEARNING OUTCOMES

Learning outcomes

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

Consult Appendix A

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

At the completion of this course students will:

1. *Understand basic concepts of mechatronic systems and electric circuits.*
2. Understand basic concepts of continuous-time and discrete-time signals and systems
3. Understand the principles of actuators and their drives, emphasis on electric motors.
4. Understand the principles of sensors, sensor interfaces, and measurement systems.
5. Understand digital controllers, emphasis on Arduino microcontrollers.
6. Ability to program Arduino microcontrollers.
7. Ability to acquire, store and process data.
8. Ability to use mechatronics instrumentation.

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

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…*
	…….

Analysis and synthesis of data and information, with the use of the necessary technology
Team work
Production of new research ideas

(3) SYLLABUS

1. **Analysis of mechatronic systems**. Parts of mechatronic system. Power and signal flow. Feedback. Interfacing. Electric circuit elements. Electric circuit analysis. Power variables.
2. **Lab instrumentation**: Power supplies. Measurements of voltage and current. Use of breadboards, digital multimeters, oscilloscope, power supplies.
3. **Signals & systems**: Continuous-time and discrete-time systems and signals. Signal discretization. Analog-to-digital and digital-to-analog conversion. PWM signals. Frequency response. Filters.
4. **Introduction to control systems**: Modeling dynamic systems. Transfer function, poles and zeros. Closed loop control systems. Root locus. PID controllers.
5. **Sensors**: Sensor types for various variables (position, velocity, acceleration, angle, angular velocity, distance, pressure, temperature, humidity, force, torque, inclination, light intensity). Basic characteristics of sensors. Measurement systems. Sampling theorem.
6. **Actuators**: Principles of electromechanical conversion, Types and characteristics of electric motors. Torque-speed curve. Models of DC motors. Motor drives and controllers. Actuators for electric, hydraulic, pneumatic and thermal systems.
7. **Digital controllers and microcontrollers**. Digital controllers, embedded systems, internet of things. Intro to computer architecture. Optic isolation. Communication protocols. Microcontroller architecture. Arduino microcontrollers.
8. **Arduino programming**. Syntax and flow control. Variables, functions and libraries. Implementing digital logic and difference equations. Applications in control and signal processing.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY
Face-to-face, Distance learning, etc.

Face-to-face,

USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
Use of ICT in teaching, laboratory education, communication with students

Laboratory exercises with the use of computer to control measurement systems and data acquisition

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	55
Laboratory	30
Assignment preparation	30
Independent study	20
Course total	**135**

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.

Short-answer questions
open-ended questions
Problem solving
Laboratory work
Assignments

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

• Bolton W. Μηχατρονική, Ηλεκτρονικά Συστήματα Ελέγχου για Επιστήμονες και Μηχανικούς, 6η Έκδοση, Εκδόσεις Τζιόλα, 2020
•Παπαδόπουλος Ε. Ηλεκτρομηχανικά Συστήματα Μετατροπής Ενέργειας, Εκδόσεις Φούντα, Αθήνα 2010.
• Alciatore D.G., Introduction to Mechatronics and Measurement Systems, 5th edition, McGraw Hill, 2019.
• Scherz P. Practical electronics for inventors, New York: McGraw-Hill, 2000.
• Bishop R. The Mechatronics Handbook, 2nd ed., CRC press, 2007.
• Παπαδόπουλος Ε. Εισαγωγή στα Ηλεκτρικά Κυκλώματα και Συστήματα, εκδόσεις Φούντα, Αθήνα, 2011.

EMY - 415 Computational Materials Science I

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	EMY-415	**SEMESTER**	8th
COURSE TITLE	COMPUTATIONAL MATERIALS SCIENCE I		

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures	3	
Office hours	2	
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).	5	5

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	SPECIAL BACKGROUND, SKILLS DEVELOPMENT, SPECIALIZED GENERAL KNOWLEDGE
PREREQUISITE COURSES:	INTRODUCTION TO COMPUTER PROGRAMMING (EMY-113)
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy415/ https://qtm.materials.uoc.gr/courses/yey/

(2) LEARNING OUTCOMES

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

Consult Appendix A

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

By the end of the course, students are expected to:

1. Know the basic techniques used for the theoretical study of materials using computers.
2. Become familiar with appropriate modeling and simulation methods for understanding the materials structure-properties relationship as well as the processes involved in several materials science problems.
3. Acquire a fundamental background in state-of-the-art programming, modelling and simulation of materials.
4. Develop scientific computing and software related technical skills.
5. Acquire hands-on experience in modeling complex phenomena and in solving challenging problems in materials science.

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6 as an advanced first cycle course and to level 7.

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…*
	…….

- Production of free, creative and inductive thinking
- Working independently
- Search for, analysis and synthesis of data and information, with the use of the necessary technology
- Project planning and management

(3) SYLLABUS

1. Introduction to materials models for computer simulations
   Length and time scales hierarchy in modeling materials structure and processes (quantum mechanical, atomistic, mesoscopic, continuum).
2. Fundamental background for classical simulations
   Brief review of classical mechanics, statistical physics, methods of numerical integration and solution of differential equations.
3. Atomic-level simulations
   Interatomic interaction potentials. Molecular dynamics method. Monte Carlo method. Initial conditions, crystal lattice construction, defects. Boundary conditions. Methods for constant temperature or/and pressure simulations.
4. Results analysis
   Equilibrium properties, structural, mechanical, dynamical properties. Specific materials properties calculation with realistic interaction potentials and comparison with experiments.
5. Introduction to first principles calculations
   The basics of density functional theory. Structural and elastic properties calculations.
6. Combining methods
   Concurrent and hierarchical combination of models. Multiple scale simulations.
7. Machine learning in atomistic simulations

Machine learning algorithms for the accurate description of interatomic interactions from first-principles calculation data, calculations on a very large spatial and temporal scale, rapid prediction of structural, elastic, and mechanical properties of materials.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Computer programming and use of specialized software in laboratory education, use of ICT in communication with students, lecture presentations, use of digital resources for further understanding taught material.
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*	
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.*	Student performance evaluation consists of mandatory exercises handed out and graded during the course of the semester and a final project with a class presentation at the end of the semester.

Activity	***Semester workload***
Lectures	26
Laboratory work	39
Study hours	75
Course total	**140**

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- A.N. Andriotis, Computational Physics, 2nd Edition, Anikoula Editions, Athens (2016).
- J.M. Thijssen, Computational Physics, Cambridge University Press, Cambridge, New York (1999).
- D. Raabe, Computational Materials Science: the Simulation of Materials Microstructures and Properties, Wiley-VCH, Weinheim, New York (1998).
- M. P. Allen, D.J. Tildesley, Computer Simulation of Liquids, Clarendon Press, Oxford (1990).
- D. Frenkel, B. Smit, Understanding Molecular Simulation: from Algorithms to Applications, Academic Press, San Diego, (1996).
- K. Ohno, K. Esfarjani, and Y. Kawazoe, Introduction to Computational Materials Science: from Ab Initio to Monte Carlo Methods, Springer-Verlag, Berlin, New York (1999).
- K. Binder, D.W. Heermann, Monte Carlo Simulation in Statistical Physics: an Introduction, Springer, Berlin, New York (1997).

- K. Binder, Monte Carlo and Molecular Dynamics Simulations in Polymer Sciences, Oxford University Press, Oxford, New York (1995).
- D.C. Rapaport, The art of Molecular Dynamics Simulation, Cambridge University Press, Cambridge, New York (2004, 1998).

EMY - 416 Computational Materials Science II: Electronic Structure

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	EMY-416	**SEMESTER**	8th
COURSE TITLE	COMPUTATIONAL MATERIALS SCIENCE II: ELECTRONIC STRUCTURE		
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	
Office hours		2	
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		5	5
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	SPECIAL BACKGROUND, SKILLS DEVELOPMENT, SPECIALIZED GENERAL KNOWLEDGE		
PREREQUISITE COURSES:	EMY-113		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES		
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy416/		

(2) LEARNING OUTCOMES

Learning outcomes

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

Consult Appendix A

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

By the end of the course, students are expected to:

6. Become familiar with the modern theory of electronic structure, and more specifically with DFT (Density Functional Theory), by employing large software packages.
7. Know the basic principles of solving quantum mechanical problems in materials science as well as how to perform computational experiments in order to study properties of standard materials.
8. Develop scientific computing and software related technical skills.
9. Acquire hands-on experience in first principles calculations for solving challenging problems in materials science.

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6 as an advanced first cycle course and to level 7 as a second cycle course.

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…*
	…….

- Production of free, creative and inductive thinking
- Working independently
- Search for, analysis and synthesis of data and information, with the use of the necessary technology
- Project planning and management

(3) SYLLABUS

1. Introduction to DFT.
Schrödinger equation for polyelectronic systems and methods for its solution. Exchange and correlation potential. Calculation of molecules energy and reactions enthalpy.

2. Crystalline solids.
Density and bulk modulus calculation using Bloch theorem. Energy bands.

3. Surfaces.
Extension of theory to semi-periodic structures. The concept of surface tension. Influence of adsorbed molecules on surface properties. Adsorption enthalpy.

4. Magnetic materials. The role of spin in the magnetic properties of materials, such as iron, as well as in the cohesion of nonmagnetic molecules, such as H_2O. The concept of density of states and its calculation. Oscillations of simple molecules.

5. Experimental techniques.
Basic principles of experiments for the depiction of the electronic structure, such as STM (Scanning Tunneling Microscope) and their simulation. Electronic band structure calculations in metals, insulators, and semiconductors.

6. Reaction speeds.
TST (Transition State Theory) and nudged elastic band method for the calculation of the speed of a chemical reaction. Application to diffusion constants calculation.

7. Machine learning for predicting electronic properties of materials
Machine learning algorithms for accurate description of interatomic interactions from DFT calculation data, effective prediction of electronic properties of materials, and other applications, such as molecule adsorption on surfaces, STM.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face	
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Computer programming and extensive use of specialized software in laboratory education, use of ICT in communication with students, presentations, use of digital resources for further understanding taught material.	
TEACHING METHODS	***Activity***	***Semester workload***

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*	Lectures	26
	Laboratory work	39
	Study hours	75
	Course total	**140**
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.*	Student performance evaluation consists of mandatory exercises handed out and graded during the course of the semester and a final project with in class presentation at the end of the semester.	

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- Antonios N. Andriotis, Computational Physics, Volume II, 1999.
- Frank Jensen, Introduction to Computational Chemistry, Wiley-VCH, 2nd edition 2006.
- Efthimios Kaxiras, Atomic and Electronic Structure of Solids, Cambridge University Press, 2003.
- Richard M. Martin, Electronic Structure: Basic Theory and Practical Methods, Cambridge University Press, 2004.
- Jos M. Thijssen, Computational Physics, Cambridge University Press, 1999.

EMY - 417 Artificial Intelligence in Materials Science

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**EMY-417**	**SEMESTER**	**7th**
COURSE TITLE	Artificial Intelligence in Materials Science		

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

Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Special background	
PREREQUISITE COURSES:	Introduction to Programming (EMY-113)	
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek / English	
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes	
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy417/	

(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*

Level 6.

Students at the end of the course will:

- Possess advanced knowledge in searching, exploring, and solving problems with predicates
- Understand Functional Programming, Neural Networks and Machine Learning
- They will be able to choose the appropriate neural network architecture to solve a classification or prediction problem
- Be able to use the Python programming environment to implement the machine learning techniques
- Have developed those skills of acquiring knowledge, which they need to continue further studies with a high degree of autonomy

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…*
	…….

- *Work independently and in Teamwork.*
- *Analytical and synthetic ability to solve problems.*
- *Critical thinking.*
- *Manages complex mathematical theories and techniques.*
- *Programming skills in new technologies.*

- *Bibliographic research, analysis, synthesis and presentation of contemporary research findings.*

The above is achieved by seeking answers to problems with different degrees of difficulty and need for synthetic ability. Students are invited to work either autonomously or collectively, both in the classroom and through homework.

(3) SYLLABUS

- Calculus, statistics and probabilities
- Linear model: regression and classification
- Loss function, normalization, generalization
- Logistic regression, decision tree, random forest, support vector machines
- Unsupervised learning (grouping, dimensional reduction)
- Deep learning (Multi-Layer Perceptrons, Convolutional, and Recurrent Neural Networks)
- Python programming (scikit-learn, pytorch, Jupyter notebook)
- Materials Databases (Materials Project, Citrination)
- Applications on materials synthesis, characterization, and engineering

(4) TEACHING and LEARNING METHODS - EVALUATION

<table>
<tr><td>DELIVERY
Face-to-face, Distance learning, etc.</td><td>Face-to-face</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
Use of ICT in teaching, laboratory education, communication with students</td><td>Use of ICT in delivery and communication with students</td></tr>
<tr><td>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</td><td>
<table>
<tr><th>Activity</th><th>Semester workload</th></tr>
<tr><td>Lectures</td><td>39</td></tr>
<tr><td>Practice</td><td>13</td></tr>
<tr><td>Homework</td><td>23</td></tr>
<tr><td>Study at home</td><td>50</td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td>Course total</td><td>125</td></tr>
</table>
</td></tr>
<tr><td>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.</td><td>Language: Greek / English
Evaluation methods: Active participation in the class (questions and quizzes) 10%, Homework/Presentations 30 %, Research project 60%.</td></tr>
</table>

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- Επιστήμη Δεδομένων: Βασικές Αρχές και Εφαρμογές με Python, Grus Joel, Α. ΠΑΠΑΣΩΤΗΡΙΟΥ & ΣΙΑ
- ΤΕΧΝΗΤΗ ΝΟΗΜΟΣΥΝΗ: ΜΙΑ ΣΥΓΧΡΟΝΗ ΠΡΟΣΕΓΓΙΣΗ, STUART RUSSELL, PETER NORVIG, ΕΚΔΟΣΕΙΣ ΚΛΕΙΔΑΡΙΘΜΟΣ
- Νευρωνικά Δίκτυα και Μηχανική Μάθηση, Haykin Simon, Α. ΠΑΠΑΣΩΤΗΡΙΟΥ & ΣΙΑ
- Python Machine Learning: Machine Learning and Deep Learning with Python, scikit-learn, and TensorFlow 2, 3rd Edition
- Artificial Intelligence-Aided Materials Design, ByRajesh Jha, Bimal Kumar Jha, CRC Press

EMY - 418 C++ Programming Language

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	MATERIALS SCIENCE AND ENGINNERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	EMY-418	**SEMESTER**	7th
COURSE TITLE	C++ Programming Language		
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 and programming exercises		3	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*	Special background		
PREREQUISITE COURSES:	*Introduction to Computer Programming (EMY-113)*		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES		
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy418/		

(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*

Upon successful completion of the course, the students will

1. have deepen their knowledge of the basic concepts of structured programming

2. be familiar with certain advanced programming concepts, as implemented in C++ (such as the Standard Library components and object-oriented programming).

3. be able to develop complex, safe and fast code as well as understand or even plan code in programming languages with features simlilar to those of C++.

General Competences

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

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

Production of new research ideas	
Solving complex problems Development of scientific thinking Use of libraries and multiple bibliographic sources Search for resources and online lessons Create notes and standalone study method Manage time and deadlines	

(3) SYLLABUS

A) General:

Introduction - Fundamental types and operators of C++.
C++ syntax, reserved keywords, naming rules. Fundamental types: boolean, character, integer, real, complex.
The "void" type. Enumerations. Declarations and scope of variables and constants. Structures.
Arithmetic operators, priorities. Namespaces, references, pointers.

Control structures, Loops.
If statement, (?:) operator, the switch statement, the assert function. Loop structures: while, do while, for. continue, break statements.

Functions
Function definition, declaration and usage. the main function. Overloading, function template. Math functions.

Exceptions.

B) Standard Library Containers: vector, deque, list, set/multiset, map/multimap. Iterators. Algorithms, function objects, lambda functions, adapters.

C) Object-Oriented Programming: Introduction to classes: encapsulation, inheritance, polymorphism.

D) Other topics Large program structure. Interface to Fortran and C.

(4) TEACHING and LEARNING METHODS - EVALUATION

<table>
<tr><td>DELIVERY
Face-to-face, Distance learning, etc.</td><td>Face-to-face</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
Use of ICT in teaching, laboratory education, communication with students</td><td>Computers and projector are used in teaching, exercises and for communicating with students (through the course website and by email).</td></tr>
<tr><td>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</td><td>
<table>
<tr><th>Activity</th><th>Semester workload</th></tr>
<tr><td>Lectures</td><td>26</td></tr>
<tr><td>Programming exercises</td><td>13</td></tr>
<tr><td>Study</td><td>91</td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
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<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td>Course total</td><td>130</td></tr>
</table>
</td></tr>
<tr><td>STUDENT PERFORMANCE EVALUATION
Description of the evaluation procedure

Language of evaluation, methods of evaluation, summative or conclusive, multiple choice</td><td>Final written exams.</td></tr>
</table>

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.*	

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- Notes: (https://raw.githubusercontent.com/sstamat/mybooks/main/cppbook.pdf)
- Bjarne Stroustrup. Programming - Principles and Practice Using C++ (Second Edition), Addison Wesley, Reading, MA, USA, 2014.
- Stanley B. Lippman, Josée Lajoie and Barbara E. Moo. C++ Primer. Addison Wesley, Reading, MA, USA, fifth edition, August 2012.
- Nicolai M. Josuttis. The C++ Standard Library: A Tutorial and Reference. Addison Wesley, Reading, MA, USA, March 2012.
- Bjarne Stroustrup. The C++ Programming Language. Addison Wesley, Reading, MA, USA, fourth edition, 2013.

- Related academic journals:

Materials Chemistry – Biomaterials

EMY - 421 Polymer Synthesis

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	EMY-421	**SEMESTER**	8th
COURSE TITLE	Polymer Synthesis		
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**
		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*	Special background, Specialization		
PREREQUISITE COURSES:	EMY-343		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek and English		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes		
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy421/		

(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*

This course develops the basic methods of polymer material synthesis. It delves into the mechanisms of polymerization and reaction kinetics. The effect of kinetics on reaction speed and the characteristics of the resulting polymers are also discussed. Finally, the basic techniques of macromolecular characterization of polymers are presented. Students select contemporary research topics in polymer synthesis for presentation (mandatory).

The learning objectives of the course are as follows:

- Understanding the effect of the polymerization method on the characteristics of the polymer.

- Consolidating the basic principles of polymerization kinetics and the ability to predict the macromolecular characteristics of polymers.

- Familiarization of students with macromolecular characterization techniques.

- Acquisition of experience in studying international scientific literature and presenting scientific topics.

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

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…*
	…….

- Development of interdisciplinary and critical thinking
- Searching for, analyzing, and synthesizing data and information, using the necessary technologies
- Independent work
- Teamwork
- Planning and managing tasks
- Promoting free, creative, and inductive thinking

(3) SYLLABUS

1. Basic concepts – Polymer nomenclature
2. Classification of polymers
3. Polymer microstructure: monomer architecture, orientation, regularity, isomerism
4. Types of polymerization reactions
5. Stepwise polymerization reactions
• Types of stepwise reactions
• Molecular weight and polydispersity
• Kinetics of stepwise reactions
• Examples
• Industrial methods of stepwise polymerization
6. Chain polymerization reactions
• Free radical polymerization
• Free radical mechanism
• Molecular weight and polydispersity
• Kinetics of free radical polymerization
• Examples
• Industrial methods of free radical polymerization
• Copolymerization
• Copolymerization kinetics
7. Anionic polymerization
• Anionic polymerization mechanism
• Molecular weight and polydispersity
• Kinetics of anionic polymerization
• Macromolecular architecture with anionic polymerization
8. Group transfer polymerization

9. Cationic polymerization
• Mechanism of cationic polymerization
• Molecular weight and polydispersity
• Kinetics of cationic polymerization
10. Ring-opening polymerization

11. Polymer modification reactions

12. Characterization of macromolecules using FTIR, UV/vis, and 1H NMR spectroscopy techniques
• Determination of copolymer composition

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of PowerPoint, communication via the Department's website and email Use of reliable scientific online sources to find bibliography and present topics to students
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*	
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.*	Students are assessed through four sets of exercises during the semester, a final written exam that includes a combination of problem solving and essay questions, and an assignment/presentation on a topic from the international literature related to the course subject. There is the possibility of an oral exam for students with learning difficulties. Students have the right to see their written exam after the results have been published and to submit questions to the instructor. The method of student assessment and the percentage of each activity in the final grade are described during the first lecture, given to students in writing, and also posted on the course website: https://www.materials.uoc.gr/courses/emy421/

Activity	*Semester workload*
Lectures	52
Exercises	12
Study of bibliography at home	52
Assignment/presentation	30
Course total	**146**

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- Προτεινόμενη Βιβλιογραφία:

- Allcock, H.R.; Lampe, F.W. Contemporary Polymer Chemistry, 2nd ed., Prentice Hall, Englewood Cliffs, 1990.
- Hiemenz, P.C. Polymer Chemistry: The Basic Concepts, Marcel Dekker, NY, 1984.
- Young, R.J.; Lovell, P.A. Introduction to Polymers, 2nd ed., Chapman & Hall, 1996.
- Stevens, M.P. Polymer Chemistry: An Introduction, 2nd ed., Oxford Univ. Press, 1990.

- Πρόσθετη βιβλιογραφία:

1. Brandrup, J. and Immergut, E.H., eds., Polymer Handbook, 3rd ed., John Wiley & Sons, New York, 1989.
2. Odian, G. Principles of Polymerization, 3rd ed., John Wiley & Sons, New York, 1991.
3. Rempp, P.; Merill, E.W. Polymer Synthesis, 2nd ed., Huthig & Wepf, Basel, 1991.
4. Cowie, L.M.G. Polymers: Chemistry and Physics of Modern Materials, 2nd ed., Chapman & Hall, Padstow, Cornwall, UK, 1998.
5. Flory, P.J. Principles of Polymer Chemistry, Ithaca, HY, Cornell University Press, 1953.
6. Σιμιτζή, Ι. Χρ. Επιστήμη Πολυμερών, Έκδοση Εθνικού Μετσοβείου Πολυτεχνείου, Αθήνα, 1994.
7. Παναγιώτου Κ. Επιστήμη και Τεχνολογία Πολυμερών, Εκδόσεις Πήγασος2000, Θεσσαλονίκη, 1996.
8. Seymour, Raymond B. and Carraher, Charles E., Giant Molecules, JohnWiley and Sons, Inc., New York, 1990.

- Related academic journals

1. Progress in Polymer Science, Elsevier
2. Macromolecules, American Chemical Society
3. Polymer Chemistry, Royal Society of Chemistry
4. Langmuir, American Chemical Society
5. Chemistry of Materials, American Chemical Society
6. Biomacromolecules, American Chemical Society
7. Advanced Materials, Wiley
8. Advances in Polymer Science, Springer-Verlag
9. Polymer, Elsevier
10. Journal of Colloid and Interface Science, Elsevier
11. Journal of Material Chemistry, Royal Society of Chemistry
12. Journal of the American Chemical Society, American Chemical Society
13. Angewandte Chemie International Edition, Wiley
14. Nature Communications, Springer Nature Limited

EMY - 424 Crystal Chemistry

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**EMY-424**	**SEMESTER**	**7th**
COURSE TITLE	Crystal Chemistry		
INDEPENDENT TEACHING ACTIVITIES		**WEEKLY TEACHING HOURS**	**CREDITS**
		4	5
COURSE TYPE	ELECTIVE		
PREREQUISITE COURSES:	-		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Mixed: Lectures in GREEK exams in ENGLISH		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES		
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy424/		

(2) LEARNING OUTCOMES

Learning outcomes
• The course discusses the study of inorganic crystalline solids. The crystal structures of the elements, binary, ternary and modular compounds is presented. Correlation between electronic structure and crystal structure using the LCAO approach. Defects in crystals and how those affect the physical properties of the solids (semiconductors, scintillators, transparent conducting oxides, etc.). Methods of crystal growth and structural characterization with X-ray diffraction. Modern technological applications of inorganic materials. The main educational goals that the students will achieve upon completion of the course include:

1. The structure of solids: Description and classifications of crystals through polyhedral representations of inorganic crystal structures.
2. Band structure: Electronic structure derived from crystal structure. Structure-property relations.
3. Non-stoichiometry and defects in crystals: Manipulation and control of the physical properties of solids.
4. Synthetic methods and characterization in inorganic solids: Crystal Growth of single-crystals, polycrystalline and amorphous solids
5. Application of Inorganic compounds in technology

- *The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.*

-Relating the structure of matter with the physical properties of solids.
-Relating the structure of matter with technological applications of advanced materials.
-Practical exercise on crystal structure determination from X-ray diffraction data.
-Skill development in writing scientific manuscripts in English
- Skill development in public presentation of a scientific topic.

(3) SYLLABUS

1. **Structure types of Solids**
α) Metals and Nonmetals
β) Binary compounds: AB, AB_2, AB_3, A_2B_3, A_xB_y
γ) Ternary compounds: ABX_2, ABX_3, AB_3, AB_2X_4, A_2BX_4, AB_2X_2
δ) Intermetallics and Zintl Phases
ε) Modular compounds: Polytypes, Homologous series and misfit layered compounds

2. Band structure (based on R. Hoffmann review).
α) Contructing "Spaghetti" diagrams starting from molecular orbitals.
β) Electronic instability(Peierls distortion, Jahn-Teller effect)
γ) Density of states, band folding, direct and indirect bandgap
δ) Quantum confinement: Low-dimensional materials, Quantum wells, Quantum wires, Quantum dots

3. Non-Stoichiometry and Defects in Crystals
α) Nonstoichiometry and diffusion. Thermal quenching, sintering, and annealing.
β) Phase diagrams, eutectics, spinodal decomposition and solid solutions.
γ) Phase transitions. Phase transitions in inorganic solids, crystals and amorphous solids.

4. Synthesis methods
α) Solid-state synthesis, wet synthesis, solvothermal synthesis
β) Crystal Growth
Growth from melts, solutions and vapor transport.
γ) Structural characterization
Structure determination from single-crystals and crystalline powders. Characterization of amorphous solids (Pair Distribution Functions (PDF))

5. Applications of Inorganic Compounds in Modern Era Technology
- *Inorganic Semiconductors in Optoelectronics*
Photodiodes in Photovoltaics, Detectors and LED's
- *Porous Materials*
Gas Separation and Catalysis
- *Hydrogen Technology*
Production, Storage and Reactivity
- *Energy Storage*
Solid State Batteries

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY.	Face-to-Face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY	Use of Power Point, Use of interactive online databases, eg database of ionic radii, physical properties of semiconductors, ICSD, CSD Use of visualization and analysis software of the crystal structure.
TEACHING METHODS	***Activity*** / ***Semester workload*** Lectures: 39 Homework: 90 Course total: **129**
STUDENT PERFORMANCE EVALUATION	Successful completion of the course involves the writing of a scientific manuscript in English (40%) (JACS Communication format) on a topic related with the technological application of inorganic materials, and its oral presentation in the class (40%). The remaining (20%) is evaluated based on the class participation and understanding throughout the course. The topic will be chosen by the student after consultation with the instructor.

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- 1) Ulrich Müller, «*Inorganic Structural Chemistry*», 2nd Edition, Wiley 2006.
- 2) Alexander F. Wells, «*Structural Inorganic Chemistry*», 5th Edition, Oxford University Press 1984.
- 3) Roald Hoffmann, «*How Chemistry and Physics Meet in the Solid State*», *Angew. Chem. Int. Ed. Engl*. (1987) 846-878
- 4) Anthony R. West. «*Solid State Chemistry and Its Applications*», 2nd Edition, Wiley 2014.
- 5) Richard J. D. Tiley, «*Defects in Solids*», Wiley 2008
- 6) Giovanni Ferraris, Emil Mackovicky, Stefano, Merlino, «*Crystallography of Modular Materials*», IUCr 2004.
- 7) Erwin Parthé «*Crystal Chemistry of Tetrahedral Structures*» CRC Press 1964

- Related Scientific Journals:

Chemistry of Materials
Materials Horizons
Nature Materials
Advanced Materials
Journal of Solid State Chemistry

EMY - 425 Solid State Chemistry

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**EMY-425**	**SEMESTER**	**8th**
COURSE TITLE	SOLID STATE 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**
	3	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*	SPECIAL BACKGROUND	
PREREQUISITE COURSES:	EMY-141	
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK	
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES	
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy425/ https://www.materials.uoc.gr/garmatas/teaching.html	

(2) LEARNING OUTCOMES

Learning outcomes

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

Consult Appendix A

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

The learning goals of the course are:
1. Understanding of the basic principles regarding the crystal structures, bonding forces, and the electrochemical, optical and semiconducting properties of materials.
2. The crystal structure and physical properties of inorganic materials.
3. An overview of the synthetic methods and physicochemical techniques for the synthesis and characterization of materials.

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

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…*
	…….

- Development of interdisciplinary and critical thinking
- Search for, analysis and synthesis of data and information, with the use of the necessary technologies
- Production of free, creative and inductive thinking

(3) SYLLABUS

1. Introduction to solid state chemistry, chemical classification of solids, dispersion forces, close packed structures, crystal structures, Bravais lattices and unit cells, Miller indices, symmetry operations and symmetry elements.

2. Bonding in solid, ionic, covalent and metallic crystals, typical structural types, intermolecular forces, ionic radius, ionic and molecular structures, lattice energy, ionic compound properties.

3. Structural defects (Schottky and Frenkel), chemical impurities and non-stoichiometric crystals, Vegard's law, non-stoichiometric oxide (FeO, TiOx) electronic properties, solid solutions.

4. Crystallography and diffraction techniques, X-ray diffraction in crystalline solids, Miller index assignment, crystal structure identification, crystallite size, atomic scattering factor, small-angle X-ray scattering.

5. Scanning and transmission electron microscopy (SEM/TEM), electron scattering, X-ray energy dispersive microscopy (EDS), electron energy loss spectroscopy (EELS), Auger spectroscopy, X-ray photoelectron spectroscopy (XPS), cathodoluminescence (CL), electron diffraction.

6. Ceramic materials synthesis, solid state reaction, combustion synthesis, pure crystals with vapour-phase transfer, vapor chemical deposition (CVD), atomic layer deposition (ALD), sol-gel method, citric method, hydrothermal and solvothermal synthesis, ceramic methods.

7. Inorganic composite materials and applications: Solid-state galvanic cells, lithium-ion batteries, fuel cells (PAFC, MCFC, SOFC), electrochromism.

8. Zeolites, mesoporous aluminosilicate frameworks, synthesis, chemical composition, crystal structure, catalytic properties.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-Face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of Power Point, Supportive learning through the use of valid online scientific sources, *e.g. https://ocw.mit.edu/courses/materials-science-and-engineering/3-091sc-introduction-to-solid-state-chemistry-fall-2010* and *http://csi.chemie.tu-darmstadt.de/ak/immel/tutorials/symmetry*, in order to understand the basic principles of solid state chemistry and the properties of non-molecular solids.
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	30
Exercises	10
Homework	90
Course total	**130**

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.*	Students are evaluated by a final written examination in Greek that includes a combination of: - Short-answer questions - Problem solving - Developing of topics - Oral examination (for students with learning disabilities) Students have the right to view their exam scripts after the grading results are published and to ask questions. The evaluation process of the students is described during the first lecture and presented on the web site of the course: https://www.materials.uoc.gr/el/undergrad/courses/ETY412/

(5) ATTACHED BIBLIOGRAPHY

- *Suggested bibliography:* 1) Anthony R. West, *Solid State Chemistry and its Applications,* 2nd Edition, Wiley, 2014. 2) Lesley E. Smart, Elaine A. Moore, *Solid State Chemistry: An Introduction,* 3rd Edition, Taylor & Francis Group, 2005. - *Related academic journals:* Journal of Solid State Chemistry Inorganic Solid-State Chemistry

EMY - 426 Natural Biomaterials

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING			
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING			
LEVEL OF STUDIES	UNDERGRADUATE			
COURSE CODE	**EMY-426**	**SEMESTER**	**8th**	
COURSE TITLE	NATURAL BIOMATERIALS			
INDEPENDENT TEACHING ACTIVITIES			**WEEKLY TEACHING HOURS**	**CREDITS**
			3	5
COURSE TYPE	ELECTIVE			
PREREQUISITE COURSES:	BIOCHEMISTRY AND MOLECULAR BIOLOGY (EMY-231) or BIOMATERIALS (EMY-341)			
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK			
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES			
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy426/			

(2) LEARNING OUTCOMES

Learning outcomes
The course outline includes the study of materials of biological origin, their molecular structure and architecture, the mechanisms of self-organization and their properties as materials. The learning goals that students should have achieved at the end of the lesson are the following: 1. To become familiar with materials of biological origin 2. To consolidate the notions of the structural mechanisms used by Nature to create materials with defined properties 3. To use this knowledge towards the design of biomimetic materials 4. To be prepared for their diploma thesis in the field of natural biomaterials and their applications in tissue engineering *The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.*
- Development of interdisciplinary and critical thinking - Search for, analysis and synthesis of data and information, with the use of the necessary

technology
- Production of free, creative and inductive thinking

(3) SYLLABUS

1. Biological introduction
2. Examples of biological materials
3. Collagen-Gelatin-Elastin-Keratin
4. Silk, spider webs, mussel collagen, amyloid fibrils
5. Cellulose, starch, cotton
6. Biological composite materials: nacre, chitin, bones, teeth
7. Diatomes and magnetotactic bacteria
8. Chitosan, hyaluronic acid, alginates
9. Design of biomimetic materials
10. Application of natural biomaterials in tissue engineering

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY.	Face-to-Face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY	Use of Power Point, Supportive learning through the use of valid online scientific tools, *eg.* proteopedia.org in order to understand biological structures
TEACHING METHODS	***Activity*** | ***Semester workload*** Lectures | 39 Homework | 86 | Course total | **125**
STUDENT PERFORMANCE EVALUATION	Students are evaluated by a final written examination in Greek that includes a combination of: - Multiple-choice questions - Developing of topics - Students have the right to view their exam scripts after the grading results are published and to ask questions.

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- C. Branden and J. Tooze, "Introduction to protein structure", Garland Publishing. Greek translation, Basdra Academic Editions, 2019

- The book largely covers the structural / biochemical aspects of the course (50% of the total material). Unfortunately, due to the interdisciplinarity of the course, there is still no textbook in Greek that combines the structural aspects with the mechanical and other properties of natural biomaterials. A combination of primary bibliography and English books is used (below).

- D. Whitford, “Proteins-Structure and Function”, Wiley, 2005

- P. R. Shewry, A.S. Tatham, A. J. Bailey, "Elastomeric Proteins: Structures, Biomechanical Properties, and Biological roles" The Royal Society and Cambridge University Press, 2003
- S. Mann, "Biomineralization: Principles and Concepts in Bioinorganic Materials Chemistry" , Oxford Chemistry Masters, 2001
- E. Gazit and A. Mitraki, "Plenty of Room for Biology at the Bottom: an Introduction to Bionanotechnology", Imperial College Press, 2013
- J.F.V. Vincent, "Structural Biomaterials", University Presses of California, Columbia and Princeton University Press (1990)
- C. Neville, "Biology of fibrous composites", Cambridge University Press (1993)
- J. Benyus, "Biomimicry - innovation inspired by Nature", Quill, William Morrow (1997)
- J. Howard, "Mechanics of the motor proteins and the cytoskeleton", Palgrave Macmillan (2001)
- S.R. Fahnestock and A. Steinbuchel, Polyamides and complex proteinaceous materials, volumes 7 and 8, in "Biopolymers", Wiley-VCH (2003)
- Vogel, S. "Comparative Biomechanics", Princeton University Press (2003)

- Related academic journals:

Biomaterials
Acta Biomaterialia
ACS Biomaterials Science and Engineering
ACS Applied Biomaterials

EMY - 427 Bioorganic Nanostructures – Supramolecular Chemistry

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**EMY-427**	**SEMESTER**	**8th**
COURSE TITLE	BIOORGANIC NANOSTRUCTURES – SUPRAMOLECULAR 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**
	3	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*	SPECIALIZED GENERAL KNOWLEDGE
PREREQUISITE COURSES:	GENERAL CHEMISTRY (EMY-121) ORGANIC CHEMISTRY (EMY-122), ENGLISH II (EMY-012).
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	HELLENIC (ENGLISH)
IS THE COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy427/ https://598bionano.wordpress.com

(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*

This course will serve to introduce important notions and concepts in the field of supramolecular chemistry through examples that dictate supramolecular organization in Nature and their comparison with published works. The goals of this course are to familiarize students to the different types of chemical systems used for the assembly of complicated molecular architectures and functional molecules, to help students obtain the essential knowledge needed to critically examine modern scientific literature related to supramolecular chemistry, and show how the notions and tools of supramolecular chemistry are applied in other areas of chemistry and biology. Upon successful completion of the course, the students will be able to:
-Understand the basic definitions and principles of supramolecular chemistry, widely used for the construction of novel materials,
-Correlate nanostructure architecture with the chemical structure of its components,
-Identify non-covalent interactions employed in self-organization and use this knowledge to understand and design new molecules and nanostructures,
-Work in multidisciplinary environments requiring basic supramolecular chemistry understanding (within the framework of a diploma thesis or Erasmus).

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

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…*
	…….

- Analyzing research papers,
- Production of me research ideas,
- Working in interdisciplinary environments,
- Autonomous work,
- Team work.

(3) SYLLABUS

The course details the basic principles of supramolecular chemistry leading to spontaneous and programmed formation of (bio)nanostructures. The course extends the basic concepts of the role of non-covalent interactions (studied in previous courses such as General Chemistry and Organic Chemistry) and explores the essential role they play in Nature and all areas of modern supramolecular materials and biomaterials chemistry. The main themes are:
1. Nanotechnology: definitions, approaches, perspectives,
2. Supramolecular Chemistry: Definition and basic principles,
3. Non-covalent interactions/self-assembly,
4. Molecular recognition – host-guest chemistry,

5. Template-directed synthesis,
6. Dynamic covalent chemistry,
7. Self-organization: Amphiphiles, polymers, helical polymers, supramolecular polymers, peptides, proteins, oligonucleotides,
8. Mechanically-interlocked molecular architectures,
9. Molecular Machines
10. Presentation and analysis of research studies from current literature.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Dedicated webpage, Book chapters, review articles, research papers, templates available on Moodle
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*	
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.*	Seminar 60% (oral presentation of a research paper from current literature). Paper 20% (written presentation of the research paper from current literature). Final exam 20% (short-answer questions).

Activity	***Semester workload***
Lectures	39
Presentations	8
Office hours	18
Independent study	60
Course total	**125**

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

1. Core Concepts in Supramolecular Chemistry and Nanochemistry, Jonathan W. Steed, David R. Turner and Karl J. Wallace. John Wiley & Sons, Ltd: Chichester. 2007.
2. Supramolecular chemistry: Concepts and perspectives, J.-M. Lehn, VCH, Weinheim 1995.
3. "Application of supramolecular chemistry", Schneider, H.J., , CRC Press 2012.

- Related academic journals:

Nature, Science, Nature Communications, Chemical Communications, RSC Advances, JACS, Angewandte Chemie International Edition, Supramolecular Chemistry

EMY - 428 Sustainable (Bio)Polymers

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIAL SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	EMY-428	**SEMESTER**	7th
COURSE TITLE	SUSTAINABLE (BIO)POLYMERS		
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**
		3	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*	Special background, Specialization		
PREREQUISITE COURSES:			
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes		
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy428/		

(2) LEARNING OUTCOMES

Learning outcomes

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

Consult Appendix A

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

The course aims to provide knowledge of the basic definitions and concepts related to the chemistry and applications of sustainable polymers in order to understand the principles governing the design and applications of biodegradable and/or bio-based plastics as alternatives to petroleum-based plastics. and bio-based plastics as alternatives to petroleum-based plastics.

Upon successful completion of the course, students will be able to:

- Understand basic definitions and principles governing the chemistry and application of sustainable polymers and biodegradable polymers

- Use sustainability terms and concepts in polymer science

- Evaluate the main characteristics of polymers in terms of sustainability

- Understand how biomass can be converted into chemical building blocks and polymers.

- Evaluate the use and fate of polymers based on their chemical structure.

- Integrate innovative techniques that can potentially enhance sustainability in experiments and project design on a laboratory and industrial scale (photochemistry, electrochemistry, flow chemistry).

- Participate in an interdisciplinary laboratory environment that requires a basic understanding of organic chemistry (as part of a thesis or Erasmus program).

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

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…*
	…….

- Searching for and analyzing sustainable polymers
- Designing new research ideas
- Working in an interdisciplinary environment
- Working independently
- Working in a team

(3) SYLLABUS

1: Introduction to plastic pollution and proposed solutions: Recycling, Biodegradable polymers. (Definitions: Biodegradable, Photodegradable/Oxodegradable, Compostable, Biomass, Carbon footprint, Life Cycle Assessment (LCA)). Basic principles of sustainable chemistry: Prevention, material economy and other sustainability metrics, use of renewable energy sources, sustainable processes, safety, reduction of energy requirements.
2: Monomers (and polymers) derived from biomass: Biorefinery.
3: Natural polymers (cellulose, starch, lignin, gelatin, chitin, chitosan, etc.): Structures, properties, advantages, and disadvantages.
4: Non-biodegradable bioplastics: polyethylene (PE), polypropylene (PP), polyethylene terephthalate (PETE or PET), polyurethane (PU), polyamide (PA).
5: Biodegradable petroleum-based polymers: poly(adipic butylene co-terephthalate) (PBAT), polycaprolactone (PCL), poly(electropolybutylene (PBS)
6: Sustainable polymers from biomass: a. poly(lactic acid) (PLA) synthesis, crystallization, properties, processing, biodegradation, applications, b. polyhydroxyalkanoates (PHAs) types, properties, synthesis, processing, applications.
7: Biosynthetics, classification, natural fibers.
8: Applications of bioplastics and biosynthetics: packaging, food, foams, pharmaceuticals (medicines and drug delivery), personal care, textiles, etc.
9: Plastic waste management: Recycling (mechanical, chemical), composting, energy from waste, incineration, landfill operations.
10: Environmental impacts, LCA of sustainable plastics, biodegradation of polymers (industrial composting, marine composting, anaerobic digestion, active landfill, home composting, solid biodegradation), determination of carbon content during biodegradation.
11: Laboratory work on: biopolymer synthesis or 3D printing of biopolymers or preparation of biopolymer composites or preparation of biopolymer gels or depolymerization.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face	
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of PowerPoint, communication via the Department's website and email Use of reliable scientific online sources to find bibliography and present topics to students	
TEACHING METHODS	***Activity***	***Semester workload***

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*	Lectures	36
	Laboratory work	8
	Office hours for student guidance and answering questions	8
	Study of bibliography at home	63
	Presentations and reports	10
	Course total	**125**

STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	Students are assessed through a final written exam that includes a combination of problem solving and essay questions, as well as laboratory work. There is the possibility of an oral exam for students with learning difficulties. Students have the right to see their written exam after the results have been released and to ask the instructor questions. The method of student assessment and the percentage of each activity in the final grade are described during the first lecture, given to students in writing, and also posted on the course website. https://www.materials.uoc.gr/courses/emy428/

(5) ATTACHED BIBLIOGRAPHY

- *Suggested bibliography:*

- 1. Applied Biopolymer Technology and Bioplastics: Sustainable Development by Green Engineering Materials, Tatiana G. Volova, A. K. Haghi, Neha Kanwar Rawat (Editors), 1st Edition, CRC Press, USA, 2021.
- 2. Green Plastics: An Introduction to the New Science of Biodegradable Plastics, E. S. Stevens, Princeton University Press, 2002.
- 3. Soil Degradable Bioplastics for a Sustainable Modern Agriculture, Ed. Mario Malinconico, Springer-Verlag GmbH Germany 2017.

- *Related academic journals*

9. Sustainable Chemistry & Engineering, ASC (https://pubs.acs.org/toc/ascecg/1/1)
10. Sustainable Materials and Technologies, Elsevier (https://www.sciencedirect.com/journal/sustainable-materials-and-technologies)Seymour, Raymond B. and Carraher, Charles E., Giant Molecules, JohnWiley and Sons, Inc., New York, 1990.

Mechanical Engineering and Materials Technology

EMY - 441 Spectroscopy

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**EMY-441**	**SEMESTER**	**8th**
COURSE TITLE	Spectroscopy		
INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*		**WEEKLY TEACHING HOURS**	**CREDITS**
	Lectures	3	5
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*	Specialized general knowledge		
PREREQUISITE COURSES:	EMY-141		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES		
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy441/		

(2) LEARNING OUTCOMES

Learning outcomes
The learning goals that students should have achieved at the end of the lesson are the following: a) The understanding by students the basic principles and concepts of using modern spectroscopic techniques in the field of materials science, such as UV-vis spectroscopy, Infrared spectroscopy (FT-IR), Raman spectroscopy, X-ray fluorescence spectroscopy (XRF), nuclear magnetic resonance spectroscopy (NMR). b) At the end of the lectures the students to obtain the basic experience of how important are the spectroscopic techniques to their science. *The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.*
General Competences
The course is formed in such a way, that during lectures and especially during the preparation of the written assignment (homework), that students will train themselves in: Searching, analysis and synthesis of data and information, with the use of the necessary technology Creative and inductive thinking Team work

(3) SYLLABUS

Introduction
Vibrational spectroscopy of molecules
Group Theory
Ultraviolet-Visible (UV-Vis) spectroscopy
Beer-Lambert Law, Electronic transitions, Visible range of the spectrum, Color - wavelength relation, Typical examples of chemical compound spectra, Absorption/Transmission/Reflection spectra in liquid and solid samples.
Fourier Transform - Infrared spectroscopy (FT-IR)
Dipolar moment, Vibrational/Rotational energy levels, Types of molecular vibrational motion, Selection rules, Instrumentation, Michelson Interferometer, Typical FT-IR spectra of organic compounds, Attenuated Total Reflectance (ATR), Applications.
Raman spectroscopy
Basic principles, Stokes/Anti-Stokes lines, Polarization, Vibration - Rotation types, Selection rules, Comparison with FT-IR: similarities and differences, laser, Instrumentation, Typical Raman spectra of organic and inorganic compounds / materials, Applications.
Fluorescence Spectroscopy
Basic principles, electronic transitions (ground and excited states), Selection rules, Instrumentation (fluorimeter), Typical fluorescence spectra of compounds, Laser Induced Fluorescence (LIF), Applications.
Nuclear Magnetic Resonance (NMR)
Magnetic field, spin, fission, Principle of chemical shift, Spectrum Types (Hydrogen 1H and Carbon 13C), Single and Multidimensional spectra (COSY, HMQC, etc.), Instrumentation, Applications in organic compounds.
Students' presentations

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY	Face-to-Face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY	Use of Power Point, of Board and video (from internet)
TEACHING METHODS	

Activity	***Semester workload***
Lectures	40
Homework and creation - presentation of the specific slides	70
Finding of time and space in laboratories (chemistry department and IESL/FORTH) for demo experiments in correlation to the theory	20
Course total	**130**

STUDENT PERFORMANCE EVALUATION	Students are evaluated by: Their presence and participation in the lectures By questions and exercises during the lectures Preparation and presentation of a topic related to spectroscopy (in groups) Students are evaluated by a final written examination in Greek that includes a combination of: - Multiple-choice questions - Developing of topics

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

1. P. Atkins, J. De Paula, "Φυσικοχημεία" Πανεπιστημιακές Εκδόσεις Κρήτης, 2018
2. Skoog, Holler, Crouch, "Αρχές Ενόργανης Ανάλυσης", 6η Έκδοση, 2007
3. D. C. Harris, "Ποσοτική χημική ανάλυση", Τόμος Β, Πανεπιστημιακές Εκδόσεις Κρήτης, 2010
4. D.C. Harris, M.D. Bertolucci, "Symmetry and Spectroscopy" (Dover, NY 1978)

- Related academic journals:
Analytical and Bioanalytical Chemistry
Spectrochimica Acta Part A
Microchemical Journal
Physical Chemistry Chemical Physics

EMY - 442 Environmental Engineering

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	MATERIALS SCIENCE AND TECHNOLOGY		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	EMY-442	**SEMESTER**	7th
COURSE TITLE	Environmental Engineering		
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	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***	Specialized general knowledge		
PREREQUISITE COURSES:			
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES		
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy421/		

(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.***
Upon successful completion of this course, students will be able to: 1. Understand the fundamental concepts and parameters of environmental pollution, including key processes and technologies for pollution control, waste management, and remediation. 2. Analyze the relationship between material structure, physicochemical properties, and functionality in the context of environmental applications. 3. Identify major material categories, their properties, and their role in environmental technologies and pollution mitigation strategies. 4. Evaluate the potential of emerging and innovative materials for pollution control applications. 5. Assess the environmental impact of materials throughout their life cycle (production, use, and end-of-life disposal) and their recyclability potential. *The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.*
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?***
• Develop interdisciplinary and critical thinking • Search, analyze and synthesize data and information using the necessary technologies • Promote free, creative and inductive thinking • Independent work

(3) SYLLABUS

- Introduction - The Field of Environmental Engineering
- Fundamentals of Environmental Pollution (Pollutant and waste categories, measurement and evaluation metrics)
- Pollutant Dynamics - Generation, transport and risk assessment (Pollutant/waste quantification, mass-energy balances, toxicity and risk evaluation)
- Core processes in pollution control technology
- Basic technologies for pollution control and environmental remediation
- Materials in Pollution Control - Classification and key characteristics (Physicochemical and structural properties)
- Surface processes in materials for pollution control and environmental-related applications:
    - Adsorption - Adsorbent materials
    - Flue gas catalysis - Catalytic materials
    - Heterogeneous photocatalysis - Photocatalytic materials
- Solid- and special solid-waste management (polymers/plastics, biodegradable polymers)
- Principles of Materials Life Cycle Assessment

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY ***Face-to-face, Distance learning, etc.***	FACE TO FACE
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY	POWERPOINT MP4

<table>
<tr><td>Use of ICT in teaching, laboratory education, communication with students</td><td></td></tr>
<tr><td>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</td><td>
<table>
<tr><th>Activity</th><th>Semester workload</th></tr>
<tr><td>Lectures</td><td>39</td></tr>
<tr><td>Homework</td><td>50</td></tr>
<tr><td>Presentation work</td><td>36</td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
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<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td>Course total</td><td>125</td></tr>
</table>
</td></tr>
<tr><td>STUDENT PERFORMANCE EVALUATION</td><td>Students are evaluated by a final written examination in Greek that includes a combination of:
Multiple-choice test
Short-answer questions
Problem-solving exercises
The final grade may be improved through:
Homework assignments
Public presentation
Students have the right to view their exam scripts after the grading results are published and to ask questions.</td></tr>
</table>

(5) ATTACHED BIBLIOGRAPHY

- Gilbert M.M., Wendell P.E. Introduction to Environmental Engineering and Science – 3d edition, 2018, publisher: KLIDARITHMOS
- Deligiannakis, I. Materials and Environment, 2011, publisher: A. TZIOLAS
- Savvakis K. Chemical Technology – Introduction to Environmental Technology, 2002, publisher: ZHTH
- Environmental Nanotechnology: Applications and Impacts of Nanomaterials (1st Ed) M. Wiesner, J.-Y. Bottero, McGraw-Hill Education, 2007.
- Degradable Polymers, Recycling, and Plastics Waste Management A-C. Albertson, S.J, Huang, 1995 Marcel-Dekker
- Materials Characterization Techniques, Sam Zhang, Lin Li, Ashok Kumar (2008) CRC Press.
- Physical Methods for Materials Characterisation, Peter E.J. Flewitt, R.K. Wild (2003) CRC Press.

EMY - 444 Photonic Materials and Devices

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING

LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**EMY-444**	**SEMESTER**	**8th**
COURSE TITLE	Photonic Materials and Devices		

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**
Credits awarded for the whole course (lectures and practice)	3	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*	Special background
PREREQUISITE COURSES:	EMY-201
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek / English
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy444/

(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*

Level 6.

Students at the end of the course:

- They will possess advanced knowledge and skills (critical understanding of theories and principles) in the field of modern Photonics, with emphasis on modern applications, like in telecommunications and nano-photonics.
- They will be able to use the knowledge they acquired in a way that shows a professional approach to their work.
- They will be able to gather and interpret elements of the subject to form scientifically documented opinion, both on scientific and social/ethical issues. (e.g. risks of new technologies to human health).
- They will be able to communicate information and solutions to the subject of the course (modern photonic materials) to both a specialized and non-specialized audience.
- They will have developed those knowledge-acquiring skills, which they need to pursue further studies with a high degree of autonomy.

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*
	Respect for the natural environment

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

- *Work independently and in Teamwork.*
- *Analytical and synthetic ability to solve problems.*
- *Critical thinking.*
- *Manages complex physical theories and mathematical techniques.*
- *Bibliographic research, analysis, synthesis and presentation of contemporary research findings.*

The above is achieved by seeking answers to problems with different degrees of difficulty and need for synthetic ability. Students are invited to work either autonomously or collectively, both in the classroom and through homework.

(3) SYLLABUS

- *Light and matter, light waves, absorption and emission, optical properties of matter*
- *Modern ultrashort and powerful lasers*
- *Optics of short laser pulses: theory and applications*
- *Nonlinear optics: materials, systems and spatio-temporal phenomena*
- *Optical fibers – Telecommunications*
- *Photonic crystals*
- *Metamaterials*
- *Terahertz photonics and devices*

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of ICT in delivery and communication with students
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	40
Study at home	60
Homework	25
Course total	**125**

STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure*	Language: Greek / English

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.*	Evaluation methods: Active participation in the class (questions and quizzes) 10%, Homework/Presentations 30 %, Research project 60%.

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- *Fundamentals of Photonics, B.E.A. Saleh and M.C. Teich, 2nd edition Wiley*
- *Photonics, A. Yariv and P. Yeh, 6th edition Oxford University Press*

- Related academic journals:

EMY - 445 Introduction to Crystallography

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING			
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING			
LEVEL OF STUDIES	UNDERGRADUATE			
COURSE CODE	**EMY-445**	**SEMESTER**	**8th**	
COURSE TITLE	Introduction to Crystallography			
INDEPENDENT TEACHING ACTIVITIES			**WEEKLY TEACHING HOURS**	**CREDITS**
			4	5
COURSE TYPE	ELECTIVE			
PREREQUISITE COURSES:	-			
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Mixed: GREEK and ENGLISH			
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES			
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy445/			

(2) LEARNING OUTCOMES

Learning outcomes

After the successful completion of the course, students are expected to:

1. Familiarize themselves with the basic principles and methods of Crystallography so much in its practical use as much as in the basic understanding of the underlying mathematical principles.
2. Familiarize themselves with the crystal structure visualization visualization software.
3. Familiarize themselves with the methodology of structural analysis of crystalline materials in Materials Science

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

- Develop interdisciplinary and judicial thinking.
- Research, analyze and compile data and information using the appropriate software.
- Promote free, creative and out-of-the-box thinking

(3) SYLLABUS

Lectures

1) Principles of X-ray diffraction
2) X-ray diffraction Instrumentation
3) Symmetry, Point groups and Space Groups
4) Bragg's Law and Lattice Parameters
5) Systematic absences, Wyckoff positions and point multiplicity
6) Reciprocal Space and the Ewald sphere
7) Atomic structure factors and atomic displacement (Debye-Waller factor)
8) Structure Factor and the Phase problem

Laboratory exercises

A) Powder diffraction
   i) Data Collection
   ii) Data plotting and interpretation
   iii) Phase identification
   iv) Data Analysis
      a) Pattern Matching
      b) Rietveld refinement
B) Single-Crystal diffraction
   i) Data collection**
   ii) Data indexing and data reduction
   iii) Space group determination and Structure solution
   iv) Structure refinement
   v) Crystal structure visualization and presentation

C) 2D X-ray diffraction patterns and Total Scattering
   i) Data Collection
   ii) Data plotting and interpretation
   iii) G(r) vs r refinement

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY.	Face-to-Face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY	Use of Power Point, Use of interactive online databases, eg database of ionic radii, physical properties of semiconductors, ICSD, CSD Use of visualization and analysis software of the crystal structure(Jana2006, Vesta, CMPR, Platon).
TEACHING METHODS	

Activity	*Semester workload*
Lectures	13
Laboratory	39

	Homework	73	
	Course total	**125**	
STUDENT PERFORMANCE EVALUATION	Students will be evaluated with homework exercises and a final exam. The final exam will deal with the structure determination of an unknown crystal structure and a 1-page structure report (without taking into account supplementary crystallographic tables).		

(5) RECOMMENDED BIBLIOGRAPHY

- Suggested bibliography:

1. *Π.Ι. Ρετζεπέρεης, Εισαγωγή στην Κρυσταλλοδομή και τη Φυσική των Ακτίνων-Χ, Εκδόσεις Γιαχούδη, Θεσσαλονίκη 1985.*
2. Χ. Β. Λιούτας. Μαθήματα για τη Δομή των Κρυσταλλικών Στερεών, *, Εκδόσεις Ροπή, Θεσσαλονίκη 2020*
3. X-Ray Structure Determination: A Practical Guide, 2nd Ed, G. H. Stout, L. H. Jensen, Wiley 1989
4. Structure Determination by X-ray Crystallography, 4th Ed, M. Ladd, R. Palmer, Kluwer Academic 2003

- Relevant Scientific Journal:
Zeitschrift für Kristallographie
Acta Crystallographica

EMY - 446 Fluid Dynamics

(1) GENERAL

SCHOOL	School of Sciences and Engineering		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**EMY-446**	**SEMESTER**	**7th**
COURSE TITLE	Fluid Dynamics		
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**
		3+1	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*	Special background		
PREREQUISITE COURSES:	Differential Equations (EMY-211)		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	No		
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy446/		

(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*

Upon completion of the course, students will:

1. Get acquainted with mathematical description of balance of mass, energy and momentum
2. Understand of various physical parameters of fluid mechanics needed for solving problems.
3. Understand of the importance and applicability of fluid dynamics in processing materials
4. Gain basic and advanced knowledge that result in critical understanding of the theory and principles of fluid dynamics.
5. Obtain specialized skills in solving problems in fluid dynamics – skills that required for research in order to develop new concepts and processes that can be integrated into different fields.

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

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*
- *Criticism and self-criticism*

(3) SYLLABUS

The class material includes a logical description of the conservation of momentum, mechanical energy and continuity for different types of materials.

SYLLABUS

- Introductory Concepts (fluids and soft matter, polymers, colloids, etc)
- Basic element of vector calculus
- Principal of mechanics of Newtonian fluids (liquids, laminar flows)
- Molecular definition of viscosity
- Conservation of Momentum, microscopic and macroscopic balances of forces and momentum
- Non-Newtonian fluids
- Dimensionless analysis
- Boundary layers, hydrodynamics, external flow, friction coefficient
- Special topics (turbulent flow, energy, time dependent flows)

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	None
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	39 hours
Study and analysis of bibliography	86 hours
Course total	**125 hours**

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.*	- *Short-answer questions* - *Problem solving* - *Public presentation*

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

Teacher Notes
R. W. Fox, A. T. McDonald, P. J. Pritchard, Introduction to fluid mechanics, 6th ed., Wiley, NY, 2006.
Introduction to fluid mechanics, 3rd ed., W. S. Janna, PWS, Boston 1993
Fundamentals of Fluid Mechanics", by Munson, Okiishi, Huebsch, Rothmayer (7th Edition, Wiley)
A physical introduction to fluid mechanics, A. J. Smits, Wiley, NY 2000

EMY - 447 Materials for Energy

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**EMY-447**	**SEMESTER**	**7th**
COURSE TITLE	Materials for Energy		

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**
	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*	Specialized general knowledge	
PREREQUISITE COURSES:		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek	
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES	
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy447/	

(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*

Materials for energy harvesting, conversion and storage hold the key to many energy related emerging technologies including photovoltaics, energy storage systems and next generation batteries, hydrogen fuel cells and supercapositors. Driven from the increasing need for safe, economically, and environmentally friendly methods for energy production and storage, it is necessary to accelerate the rate at which new energy-related are developed. Materials science and engineering hold the key for the realization of emerging energy-related technologies as the solutions to the corresponding challenges are limited by the available material technologies. The aim of this course is to provide the theoretical background to future materials engineers so to create and develop new materials in odder to address the energy challenges facing the society.

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

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
- Adapting to new situations
- Working independently
- Working in an interdisciplinary environment
- Production of new research ideas

(3) SYLLABUS

- Carbon materials of different dimensionalities – present and next generation
- Oxide materials and their application in energy research

- Two-dimensional materials for energy production and storage
- Perovskite based materials for solar cell
- Photocatalytic materials for hydrogen production
- Novel materials for enhance battery performance
- Heterostructured nano-materials and nanocomposites
- Materials For Li-ion and Beyond Li-ion Batteries
- Novel Materials for supercapacitors

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-Face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Power Point, electronic correspondence (e-mail) for communication with students
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 | 39 Homework | 86 Course total | 125
STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	Written final exam or paper with oral presentation on a selected topic

(5) ATTACHED BIBLIOGRAPHY

Course materials provided by instructor
"Energy Materials: A short Introduction to Functional Materials for Energy and Conversion", Aliaksandr S. Bandarenka 1st ed CRC Press, New York, 2021
"Materials for Energy", Edited by Sam Zhang, 1st ed., CRC Press, New York, 2021.
"Batteries: Materials principles and characterization methods", Edited by Chen Lia, IOP ebooks, 2022
Emerging Photovoltaic Material: Silicon & Beyond (Advanced Materials), edited by Santosh K. Kurinec, 1st ed. Wiley, Beverly, MA, 2018

EMY - 448 Biomedical Engineering

(1) GENERAL

SCHOOL	School of Sciences and Engineering		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**EMY-448**	**SEMESTER**	**7th**
COURSE TITLE	Biomedical Engineering		
INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*		**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures		3	5
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*	Special background		
PREREQUISITE COURSES:	EMY-231 or EMY-232 or EMY-341		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes		
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/el/undergrad/courses/EMY448/		

(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*

Upon completion of the course, students will:

1. Get acquainted with the mammalian physiology from the engineering an physics perspective
2. Get acquainted with the mechanical forces exerted on cells and tissues, and the mechanisms of transmission of the mechanical signal and its conversion into a biochemical signal.
3. Get familiarized with examples of applications of Biomedical Engineering to various branches of Medicine.
4. Obtain gain basic and advanced knowledge in biomedical engineering that entails a critical understanding of theories and principles of engineering, biology and medicine
5. Obtain specialized problem-solving skills in biomedical engineering, which are required in research

and / or innovation in order to develop new knowledge and processes and integrate knowledge from different fields.

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

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
- Criticism and self-criticism

(3) SYLLABUS

The course content includes introduction to basic concepts of Biomedical Engineering, a new branch of Life Sciences, with a strong interdisciplinary approach and many applications in Biomedical Sciences.

SYLLABUS

- Basic concepts of vascular engineering and cardiovascular physiology.
- Interaction of Mechanical and Genetic Factors in Atherosclerosis.
- Bioreology. Viscosity and Viscoelastic Properties of Blood.
- Cellular Engineering and Mechanotransduction.
- Mechanical Properties of Cell Membrane.
- Stem Cell Engineering and New Therapeutic Applications.
- Viscoelastic Properties of the Extracellular Matrix of the Cell.
- Artificial blood and polymer solutions that simulate the Rheological Properties of Blood.
- Tissue engineering of joints.
- Examples and Applications of Biomedical Engineering.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	None
TEACHING METHODS *The manner and methods of teaching are described in detail. Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.*	

Activity	*Semester workload*
Lectures	39 hours
Study and analysis of bibliography	95 hours

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		
	Course total	**134 hours**
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.*	- *Short-answer questions* - *Problem solving* - *Public presentation* - *Written work*	

(5) ATTACHED BIBLIOGRAPHY

- *Suggested bibliography:* Fundamentals of Fluid Mechanics", by Munson, Okiishi, Huebsch, Rothmayer (7th Edition, Wiley)

EMY - 449 Rheology and Polymer Processing

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING			
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING			
LEVEL OF STUDIES	UNDERGRADUATE			
COURSE CODE	**EMY-449**	**SEMESTER**	**8th**	
COURSE TITLE	Rheology and Polymer Processing			
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**
			3	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*	SPECIAL BACKGROUND			
PREREQUISITE COURSES:	DIFFERENTIAL EQUATIONS (EMY-211)			
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK			
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES			
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy449/			

(2) LEARNING OUTCOMES

Learning outcomes

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

Consult Appendix A

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

- The course includes a simple description of processing of polymeric systems.
-

The learning goals of the course are:

- 1. Familiarization of students with various methods of polymer processing.
- 2. Addressing simple problems of polymer processing with synthesis of knowledge from polymers and transport phenomena
- 3. Understanding the importance of polymers in the production of several everyday life products.
-

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

-

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…*
	…….

- Development of analytical, interdisciplinary and critical thinking
- Develop methodology for the simplification and solution of difficult problems with practical significance
- Production of free, creative and inductive thinking

(3) SYLLABUS

1. Molecular origin of viscosity, entropic origin of elasticity.
2. Non-Newtonian fluids and linear viscoelasticity.
3. Constitutive equations and non-Newtonian phenomena.
4. Introduction to polymer processing.
5. Flow of polymer melts in conduits.
6. Examples of polymer processing operations (extrudate swell and melt fracture, extrusion of thermoplastics, calendaring, blow molding).
7. Special topics (main forces – excluded volume, van der Waals, electrostatic, hydrodynamic, hydrogen bonding, applications in rheology of polymer melts and solutions, hard and soft spheres, concentration dispersions and microstructure, thixotropy, sedimentation, rheometry, extensional rheology).

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-Face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY	Power Point, electronic correspondence (e-mail) for communication with students

Use of ICT in teaching, laboratory education, communication with students	

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	39
Exercises	13
Homework	73
Course total	**125**

STUDENT PERFORMANCE EVALUATION

Description of the evaluation procedure

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

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

Students are evaluated with homework problems, project (dependent on students interest), participation (mandatory) in class and response to questions, and final exam in Greek which involves solution of problems.
Oral examination is offered to students with learning disabilities. Students have the right to see their exam after the grades are announced and ask questions.
The course evaluation is discussed during the first class and posted on the web.
https://www.materials.uoc.gr/courses/emy449/

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

1. Σημειώσεις διδάσκοντα
2. Ε. Μητσούλη, Βασικές αρχές μορφοποίησης πολυμερών, ΕΜΠ, Αθήνα 1999
3. D. G. Baird, D. Collias, Polymer processing: principles and design, Wiley, New York 1998
4. J. M. Dealy, K. F. Wissbrun, Melt rheology and its role in plastics processing, Springer 1999
5. J. M. Dealy, J. Wang, Melt rheology and its applications in the plastics industry, Springer 2013
6. R. G. Larson, The structure and rheology of complex fluids, Oxford, NY 1999
7. C. Macoscko, Rheology, WCH, NY 1994 (new edition 2024)
8. J. Vlachopoulos, N. D. Polychronopoulos, Understanding rheology and technology of polymer extrusion, Polydynamics Inc., Ontario, Canada 2019.
9. M. M. Denn, Polymer melt processing, Cambridge, NY 2008
10. R. I. Tanner, Engineering Rheology, 2nd ed., Oxford 2000
11. N. J. Wagner, J. Mewis, Theory and applications of colloidal suspension rheology, Cambridge, 2021

- Related academic journals:

Journal of non-Newtonian Fluid Mechanics
Journal of Rheology
Rheologica Acta
Polymer Engineering and Science

EMY - 541 Surfaces and Interfaces of Materials

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**EMY-541**	**SEMESTER**	**7th**
COURSE TITLE	Surfaces and Interfaces of Materials		

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**
	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*	Specialized general knowledge
PREREQUISITE COURSES:	
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy541/

(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*

1. The students will develop a fundamental understanding of the concept of the surface of a solid material (and the interfaces between two different phases) as a region of the solid that is an extension of its bulk but with modified properties that requires specific characterization techniques and with distinct applications.
2. The students will be introduced to the ultrahigh vacuum technology and its basic principles for the experimental study of surfaces and thin films.
3. The students will get familiar with the basic physical and chemical characteristics of the crystalline surfaces (chemical composition, structure/morphology, electrical properties, transport properties and chemical reactivity), the main experimental techniques for interrogate the properties of surfaces and interfaces, and the corresponding technological applications in several application in the chemical and material science industrial sector and

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

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 *Project planning and management*

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

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

(3) SYLLABUS

Introduction to the basic principles and physical concepts of surfaces, interfaces, and thin films

Solid-liquid interfaces and contact angle

Atomic structure of surfaces: vectors, surface concentrations and surface tension

Preparation approaches and structure/morphology of thin films (atomic and molecular structure, influence substrate and interfacial interactions on the final properties of films)

High vacuum and deposition techniques (sputtering, epitaxy, etc)

Emerging applications of thin films and artificial superstructures

Catalysis and adsorption processes of molecules and macromolecules on surfaces and adsorption isotherms

Experimental techniques for the characterization of surfaces, interfaces and thin films (spectroscopic techniques for the chemical characterization of surfaces, electron and X-ray diffraction, scanning probe microscopy, etc)

Physical properties of nanoparticles: particle shape and crystals, energy levels

Nanoparticles in soft matters: synthesis, characterization and properties

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-Face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Power Point, electronic correspondence (e-mail) for communication with students
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	39
Exercise	13
Homework	73

	Course total	**125**
STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	Written final exam or paper with oral presentation on a selected topic	

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- "Introduction to Surface Physics, Oxford Science Publication, Clarenton Press, Oxford 1994.
- "Introduction to Surface and Thin Film Processes", John A. Venables, Cambridge University Press
- "Materials Science of Thin Films", M. Ohring, Academic Press

EMY - 542 Tissue engineering applications in regenerative medicine

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**EMY-542**	**SEMESTER**	**8th**
COURSE TITLE	Tissue engineering applications in regenerative medicine		
INDEPENDENT TEACHING ACTIVITIES		**WEEKLY TEACHING HOURS**	**CREDITS**
		3	5
COURSE TYPE	ELECTIVE		
PREREQUISITE COURSES:	BIOMATERIALS (EMY-341)		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES		
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy542/		

(2) LEARNING OUTCOMES

Learning outcomes
The course outline includes the study of biomaterials and composite biomaterials, their physicochemical and

mechanical properties, their degradation mechanisms, their biocompatibility criteria and evaluation, the biological responses following an implantation. The learning goals that students should have achieved at the end of the lesson are the following:

1. To become familiar with the physicochemical and mechanical properties of biomaterials that determine their processes in 3D structures
2. Establish mechanisms of biocompatibility and biological responses of biomaterials and scaffolds after implantation
3. To use this knowledge to solve problems and design biomaterials and 3D scaffolds with processing technologies for tissue regeneration applications
4. To be conceptually prepared to perform a diploma thesis in a research laboratory in the area of biomaterials, tissue engineering and regenerative medicine

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

- Development of interdisciplinary and critical thinking
- Search for, analysis and synthesis of data and information, with the use of the necessary technology
- Production of free, creative and inductive thinking

(3) SYLLABUS

15. Fundamentals and recent advances in tissue engineering
16. Types, properties, applications of biomaterials and 3D scaffolds, tissue-biomaterial interactions, medical requirements and clinical significance, disinfection and sterilization of biomaterials and scaffolds
17. Phenomena at the interfaces, protein adsorption, molecular and cellular processes with the biological environment, short and long term reactions to the body
18. Fundamentals on stem cells and their application in tissue engineering
19. Scaffold fabrication and biofabrication technologies
20. Biomechanics and mechanics of scaffolds
21. Bone and cartilage tissue engineering
22. Dental tissue engineering
23. Cardiovascular tissue engineering
24. Regulatory, practical and ethical issues of biomedical devices

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY.	Face-to-Face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY	Use of Power Point, Supportive learning through the use of valid online scientific tools
TEACHING METHODS	

Activity	***Semester workload***
Lectures	39
Homework	86

	Course total	**125**
STUDENT PERFORMANCE EVALUATION	Students are evaluated by a final written examination in Greek that includes critical development of topics. Students have the right to view their exam scripts after the grading results are published and to ask questions.	

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- Tissue Engineering, Edited by J. P. Fisher, A. G. Mikos, J. D. Bronzino, CRC Press, 2007.Το βιβλίο καλύπτει κατά 100% τη συνολική διδασκόμενη ύλη.
- The text book covers 100% of the examination matter.
- Additional bibliography:

- 1. Introduction to Biomedical Engineering, Third Edition, J. Enderle, J. D. Bronzino, 2012, Elsevier
- 2. Biomaterials Science: An Introduction to Materials in Medicine, 2nd Edition, Editors: Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons 2004, ISBN 0-12-582-463-7.
- 3. Biomaterials: The Intersection of Biology and Materials Science, Johnna S. Temenoff, Antonios G. Mikos 2008, ISBN-10: 0130097101.

- *- Related academic journals: Biomaterials, Tissue Engineering Parts A, B, C, Journal of Biomedical Materials Research*

EMY - 543 Nanotechnology and Nanomedicine

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIAL SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	EMY-543	**SEMESTER**	7th
COURSE TITLE	NANOTECHNOLOGY AND NANOMEDICINE		
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**
		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*	Special background, Skills Development		
PREREQUISITE COURSES:	EMY-122		

	EMY-221
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek or English
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy543/

(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*

This course develops the basic principles of nanotechnology and nanoparticles with applications in medicine. It delves into drug delivery systems and nanosystems used in diagnostic methods. It also discusses modern nanotechnology tools for combined treatment and diagnosis. Finally, examples of nanotechnology systems with applications in nanomedicine are presented, as well as issues related to the toxicity of nanoparticles, regulatory provisions, and ethics. Students select contemporary research topics in the field for presentation (compulsory).

The learning objectives of the course are as follows:

- Understanding the application of nanotechnology in medicine.

- Familiarization of students with the techniques of characterizing nanosystems.

- Consolidation of the basic principles governing drug delivery to the body and diagnostic methods.

- Correlating the characteristics of nanosystems with their toxicity.

- Gain experience in studying international scientific literature and presenting scientific topics.

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

General Competences

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

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

- Development of interdisciplinary and critical thinking
- Search, analysis, and synthesis of data and information, using the necessary technologies
- Independent work
- Teamwork
- Generating new research ideas
- Planning and managing tasks
- Promoting free, creative, and inductive thinking

(3) SYLLABUS

1. Introduction to nanoparticles (e.g., liposomes, micelles, polymeric particles, inorganic nanoparticles, etc.). Synthesis and physicochemical characteristics of nanomaterials.

2. Drug carriers: structure, encapsulation capacity, and encapsulation efficiency. Pharmacokinetics and biodistribution, pharmacodynamics, metabolism, and absorption of nanoparticles. Targeted and controlled drug delivery with smart nanosystems.

3. Diagnosis and bioimaging: Types of nanoparticles in medical imaging, diagnosis, and imaging of cells and tissues.

4. Nanotechnology systems for simultaneous diagnosis and treatment (theranostic agents): Diagnostic and therapeutic techniques.

5. Nanoparticle toxicity: effect of size, composition, structure, surface chemistry, and dosage.

6. Case studies and examples of nanomedicine.

7. Transition from research to clinical application.

8. Regulatory aspects and ethical issues in nanomedicine.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of PowerPoint, communication via the department's website and email Use of the course website and reliable scientific online sources to find bibliography and present topics to students, notes via the educational platform Use of Power Point, communication via the department website and e-mail
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	39
Exercises	12
Study and analysis of bibliography at home	50
Assignment/presentation	24
Course total	**125**

STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	Students are assessed through a final written exam that includes a combination of problem solving and essay questions, and an assignment/presentation on a topic from the international literature on the subject of the course. There is the possibility of an oral exam for students with learning difficulties. Students have the right to see their written exam after the results have been published and to submit questions to the instructor. The method of student assessment and the percentage of each activity in the final grade are described during the first lecture, given in writing to students, and also posted on the course website.: https://www.materials.uoc.gr/courses/emy543/

(5) ATTACHED BIBLIOGRAPHY

- *Suggested bibliography:*

1. “Drug Delivery - Engineering Principles for Drug Therapy”, by Mark Saltzman, Oxford University Press, 2001.
2. Guozhong Cao, “Nanostructures and Nanomaterials – Synthesis, Properties and Applications”, Imperial College Press 2006.
3. “Nanostructured materials: Processing, Properties and Potential Applications”, Edited by Carl. C. Koch, Noyes, William Andrew, 2nd edition, 2002.
4. Malcolm Rowland, Thomas Tozer, “Clinical Pharmacokinetics and Pharmacodynamics, Concepts and Applications”, 4th Edition, Wolters Kluver, 2011.
5. “Understanding Nanomedicine: An Introductory Textbook” by Rob Burgess, Jenny Stanford Publishing, 2012.
6. “Nanomedicine for Cancer Therapy: From Chemotherapeutic to Hyperthermia-Based Therapy”, Piyush Kumar, Rohit Srivastava, 1st edition, Springer, 2017.
7. “Nanotoxicology, Materials, Methodologies, and Assessments”, Editors: Durán Nelson, Guterres Silvia S., Alves, Oswaldo Luiz (Eds.) Springer, 2014.
8. Maria Kaliva, Maria Vamvakaki, “Nanomaterials characterization”, Chapter 17, In Polymer Science and Nanotechnology, Fundamentals and Applications, Edited by Ravin Narain, Elsevier, 2020.
9. Raj Bawa and Summer Johnson “Emerging Issues in Nanomedicine and Ethics” Chapter 11, In Nanotechnology and Society: Current and Emerging Ethical Issues, Editors: F. Allhoff, P. Lin, Springer, 2009.
10. Harry F. Tibbals, «Ιατρική νανοτεχνολογία και νανοϊατρική», Εκδόσεις Παπαζήση, 2021.

-

- *Related academic journals*
    - Nature, Science, Nature Communications, Biomaterials, Biomaterials Advances, Journal of Controlled Release, Advanced NanoBiomed Research, Smart Medicine, Bioconjugate Chemistry, Biomacromolecules, ACS Biomaterials Science & Engineering, Molecular Pharmaceutics, Journal of Medicinal Chemistry, Acta Biomaterialia, Materials Today Bio.

EMY - 544 Mechanics of nanomaterials and biomaterials

(1) GENERAL

SCHOOL	School of Sciences and Engineering		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**EMY-544**	**SEMESTER**	**7th**
COURSE TITLE	Mechanics of nanomaterials and biomaterials		
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		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*	Special background		
PREREQUISITE COURSES:	Mechanics of Materials (EMY-342)		

LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy544/

(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*

Upon completion of the course, students will:

6. Know the types of forces that dominate the mechanical behavior of nanosystems.
7. Know how nanomechanics define the mechanical behavior of macromolecules, biopolymers, cells, tissues, and biomaterials.
8. Know key analytical and experimental methods utilized to study the mechanics of macromolecules, biopolymers, cells, tissues, and biomaterials
9. Have been exposed to recent research in the nanomechanics of macromolecules, biopolymers, cells, tissues, and biomaterials

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

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, analyze and synthesize data and information
- Working independently
- Team work
- Read and analyse scientific texts.

(3) SYLLABUS

Forces in nano-scale: forces between atoms and molecules, forces between molecules and surfaces, forces between proteins, forces between proteins and surfaces, forces in colloids, the effect of the electric double layers (EDL).
Analytic models: energy potentials, macromolecule chain models WLC, viscoelasticity models, macroscopic and microscopic description of the mechanical behavior of tissues and biomaterials.

Experimental methods and instrumentation: force spectroscopy, AFM, single-cell force mechanics, nano-identation, traction force microscopy, strain estimation via nonlinear optical spectroscopy, elastography. Force versus distance curves.
Biomechanics and mechanobiology: cell adhesion receptors and ligands, molecular mechanisms of stiffness perception by cells.
Case studies: single-cell mechanics of red blood cell, mechanical behavior of DNA macromolecules, mechanical behavior of titin, mechanical behavior of articular cartilage, mechanical interactions of proteins with biomaterials, biomechanical effects in regenerative medicine.

(4) TEACHING and LEARNING METHODS - EVALUATION

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

Activity	***Semester workload***
Lectures	39 hours
Study and analysis of bibliography	86 hours
Course total	**125 hours**

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.*	- *Short-answer questions* - *Problem solving* - *Public presentation* - *Written work*

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- Lecture slides.
- Scientific papers and articles.

General Interest

EMY - 461 Innovation And Entrepreneurship

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**EMY-461**	**SEMESTER**	**7th**
COURSE TITLE	Innovation And Entrepreneurship		
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**
		4	6
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).			
COURSE TYPE	GENERAL BACKGROUND & SKILLS DEVELOPMENT		
PREREQUISITE COURSES:	-		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES		
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy461/		

(2) LEARNING OUTCOMES

Learning outcomes

At the end of the course students are expected:

- To familiarize themselves with the characteristics of the entrepreneur, their traits & typology.
- To know how innovation leads to new product development and differentiation form the competition.
- To know how geographic, social, cultural and economic proximity, as well as participating in social networks and in innovation systems helps the birth of innovations and new products.
- To learn how to recognize entrepreneurial opportunities and design products according to the principles of sustainable development.
- To learn how to design a firm and how to raise funding.

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.

General Competences

The course is formed in such a way, that during lectures and especially during the preparation of the written assignment (homework), that students will train themselves in:

- Business opportunity discovery
- Creation of business motivation

- Team work
- Creative and inductive thinking
- Conceiving new business ideas
- Criticism and self-criticism
- Show social responsibility following the principles of sustainable development
- Presenting their business plan briefly and clearly to investors

(3) SYLLABUS

1. Innovation and the characteristics of startup entrepreneurs
2. Geographic, social, cultural and economic proximity – innovations systems – science & technology parks – startup incubators & accelerators.
3. Entrepreneurship, modern global challenges and sustainable development
4. Social Economy & entrepreneurship
5. New technologies & private investments
6. From the idea to business
7. The basics of a business plan
8. Elements of marketing
9. Sources of venture funding

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY	Face-to-Face & Distance Learning
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY	Use of Power Point, of Board and Supportive learning through teleconference tools,
TEACHING METHODS	

Activity	***Semester workload***
Lectures	52
Written assignment (Homework) and oral presentation in the class of their written assignment	73
Course total	**125**

STUDENT PERFORMANCE EVALUATION	Students are evaluated by: 1. Their participation in the class 2. The quality of written assignment (homework) relevant to the course's syllabus. 3. The oral presentation in the class of their written assignment. 4. The final written examination in Greek that includes a combination of: - Multiple-choice questions - Developing of topics Students have the right to view their exam scripts after the grading results are published and to ask questions.

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

1. Andrew Metrick, Ayako Yasuda Venture Capital and the Finance of Innovation, ISBN-13: 978-0470454701
2. Handbook of Entrepreneurship Research: An Interdisciplinary Survey and Introduction, Springer New York Dordrecht Heidelberg London, ISBN 978-1-4419-1190-2
3. The handbook of the small and medium-sized entrepreneur – Practical guide for a profitable small and medium-sized firm, Nikos E. Skoulas, NSA Editions, ISBN: 960406276X.

- Related academic journals:

4. Harvard Business Review
5. Journal of Business Venturing
6. Journal of Business Research
7. Strategic Entrepreneurship Journal
8. Journal of Technology Management Innovation

EMY - 462 Exploitation of Research Outpout and Entrepreneurship

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**EMY-462**	**SEMESTER**	**8th**
COURSE TITLE	Exploitation of Research Outpout and Entrepreneurship		
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**
		4	6
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).			
COURSE TYPE	GENERAL BACKGROUND & SKILLS DEVELOPMENT		
PREREQUISITE COURSES:	-		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES		
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/courses/emy462/		

(2) LEARNING OUTCOMES

Learning outcomes
At the end of the course students are expected: • To familiarize themselves with the mechanisms of berth, maturation and diffusion of intellectual property. • To know how intellectual property policy shapes the research process. • To know the research and innovation policies in Greece and in the EU. • To learn in practice how academic institutions transfer technology in the market, either in the form of spin-offs or through licensing. *The course according to the European Qualifications Framework for Lifelong Learning belongs to level 6.*
General Competences

The course is formed in such a way, that during lectures and especially during the preparation of the written assignment (homework), that students will train themselves in:

- Search for, analysis and synthesis of data and information, with the use of the necessary technology
- Creative and inductive thinking
- Team work

(3) SYLLABUS

1. The research process and the birth of knowledge,
2. The global process of knowledge diffusion,
3. Technology matureness and the dilemma of technology protection,
4. Knowledge and intellectual property diffusion through research consortia,
5. The effect of patent filing in forming the public research policy and the dissemination of the academic knowledge.
6. National and regional research and economic growth policies – smart specialization strategy,
7. The new research structures and policies in the EU – Horizon Europe 2021-2027,
8. The role of universities in the creation of spin-offs and startups in the local economic growth.

(4) TEACHING and LEARNING METHODS - EVALUATION

<table>
<tr><td>DELIVERY</td><td>Face-to-Face & Distance Learning</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY</td><td>Use of Power Point, of Board and
Supportive learning through teleconference tools,</td></tr>
<tr><td>TEACHING METHODS</td><td>
<table>
<tr><th>Activity</th><th>Semester workload</th></tr>
<tr><td>Lectures</td><td>52</td></tr>
<tr><td>Written assignment (Homework) and oral presentation in the class of their written assignment</td><td>73</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Course total</td><td>125</td></tr>
</table>
</td></tr>
<tr><td>STUDENT PERFORMANCE EVALUATION</td><td>Students are evaluated by:
5. Their participation in the class
6. The quality of written assignment (homework) relevant to the course’s syllabus.
7. The oral presentation in the class of their written assignment.
8. The final written examination in Greek that includes a combination of:
- Multiple-choice questions
- Developing of topics
Students have the right to view their exam scripts after the grading results are published and to ask questions.</td></tr>
</table>

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

1. Greenhalgh, C. and Rogers, M. (2010), Innovation Property and Economic Growth, Princeton Univ. Press, ISBN: 9780691137995
2. Swann, G.M. (2009), The Economics of Innovation: An Introduction, Edward Elgar Publishing, ISBN: 978 1 84844 006 7.

- Related academic journals:

1. International Journal of Research in Marketing
2. Curriculum Open-access Resources in Economics
3. Technological Forecasting & Social Change
4. International Journal of Industrial Organization
5. Research Policy
6. Strategic Management Journal
7. The Journal of Technology Transfer
8. Technovation