UNIVERSITY OF CRETE

DEPARTMENT OF MATERIALS SCIENCE AND TECHNOLOGY

COURSE OUTLINES

MSc in Materials Science and Engineering / Επιστήμη και Μηχανική των Υλικών

2024

Contents

COURSE OUTLINES

FIRST SEMESTER – CORE COURSES

MEMY-501. Advanced Solid-State Materials and Nanostructures

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	MATERIALS SCIENCE AND TECHNOLOGY		
LEVEL OF STUDIES	POSTGRADUATE		
COURSE CODE	**MEMY-501**	**SEMESTER**	**1st**
COURSE TITLE	Advanced Solid-State Materials and Nanostructures		

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	10
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
PREREQUISITE COURSES:	
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	ENGLISH
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	https://mscs.uoc.gr/dmst/?courses=course-b

(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 educate postgraduate students in the field of nanotechnology, especially on inorganic nanomaterials and their magnetic and opto-electronic properties. The course syllabus includes the following topics:

(1) Modern techniques and methods (physical and chemical) for synthesis of single-crystals and inorganic nanostructured materials, with emphasis on those of nanochemistry. The study focuses on development of thin films, nanoparticles, nanotubes/nanowires and porous nanostructures.

(2) An introduction to the opto-electronic and magnetic properties of semiconductor nanostructures. The basic principles of spin-electronics (spintronics) as well as the spin-dynamics in semiconductor nanostructures are described. Also, the optical and electronic properties of two-dimensional crystals, with particular emphasis on the transition metal dichalcogenides, are presented.

Students become familiar with the topics of the course through reference to the fundamental principles as well as selected examples from recent literature.

The course according to the European Qualifications Framework for Lifelong Learning belongs 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…*
	…….

- Development of interdisciplinary and critical thinking

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

- Working independently

- Working in an interdisciplinary environment

- Production of free, creative and inductive thinking

(3) SYLLABUS

A. Inorganic nanostructures and nanomaterials

1. Introduction to nanochemistry concepts

Why nano? What is Nanochemistry? Self-assembly of molecules and materials, Molecular vs. Supermolecular chemistry, "Bottom-Up" and "Top-Down" synthetic routes, Hierarchical assembly, Directing self-assembly, Size tunable physical and chemical properties of nanostructured materials, Surface vs. bulk properties of nanomaterials.

2. Chemical pattering and lithography

Scanning probe nanolithography (SPN): Scanning tunneling microscope (STM) and atomic force microscopy (AFM), Photolithography, Electron-beam and focused ion-beam lithography, Nanoimprinting, Soft lithography and self-assembled monolayers (SAMs), Dip pen nanolithography (DPN).

3. Nanostructured materials

0D nanostructures: Synthesis of metal (Au, Pt) and metal oxide (ZnO, Ga_2O_3, SnO_2) nanoparticles, Colloidal synthesis of semiconductor nanoparticles (CdQ, PbQ, Q=S, Se, Te; ZnS, InP, GaP), Self-assembly of nanoclusters and nanoparticles. 1D and 2D nanostructures: nanorods and nanowires from soft and hard templates, Semiconducting nanowires (GaN, GaAs, InAs), Carbon nanotubes.

4. 3D Nanostructures: Nanoporous materials

Supramolecular self-assembly of microporous materials (Zeolites and coordination polymers), Synthesis of periodic ordered mesoporous materials: liquid-crystal template of amphiphilic molecules and hard templating (nanocasting), Mesoporous semiconductors (Ge, GeQ, Q=S, Se, Te; CdS).

B. Synthesis and growth techniques in the solid state

5. Introduction to solid state synthesis and crystal growth

Reactions in the solid state. Ion diffusion. Epitaxy vs. Topotaxy. Crystal growth mechanisms. Laboratory Scale Crystal Growth Methods (Supersaturation in Solution, Growth from the Melt, Vapor Transport, Autoclave Growth). Industrial Scale methods (Bridgeman, Czochralski, Molecular Beam Epitaxy Methods, Autoclave Growth).

6. Deposition methods in thin films

Homogeneous Deposition (*Bottom-Up Methods*: Spin Coating, Spray Pyrolysis, Electro-spraying, Combustion, "Dr. Blade" method, Sputtering, Printing *Top-Down Methods*: Mechanical exfoliation, Chemical exfoliation, Cleavage across Crystallographic Planes). Heterogeneous Deposition (Chemical Vapor Deposition, Atomic Layer Deposition, Sublimation).

7. Application of semiconductor thin-films

Emerging Photovoltaics Technologies, CdTe, CIGS, CZTS, organic solar cells, Graetzel cells. Performance evaluation and Characterization.

8. Halide perovskite Semiconductors

Synthesis and Crystal Growth of Halide Perovskites, Structure and Properties of Halide Perovskites, Optical and Electrical Properties of Halide Perovskites.

C. Opto-electronic and magnetic materials

9. Semiconductor physics and spin

Basic semiconductor physics (the role of impurities, optical orientation, selection rules and spin detection), Spin-dynamics in semiconductor quantum wells (QWs) and quantum dots (QDs), Spin scattering in semiconductor quantum wells (QWs) and quantum dots (QDs), Spin scattering in semiconductors, the Hanle effect and the measurement of the exciton recombination and spin relaxation times, spin interactions (exchange, orbital and spin coupling).

10. Spin-LEDs: Fundamental principles and applications

Si and GaAs based light emitting diodes (spin-LEDs), Spin injection contacts (Schottky and oxide-based contacts), Magnetic contacts (magnetic semiconductors and ferromagnetic metals), Faraday and Voigt geometries.

11. Spin injection from magnetic contacts to semiconductor nanostructures III-V

Spin injection, transport and dynamics from magnetic contacts (magnetic semiconductors and ferromagnetic metals) in semiconductor quantum wells and quantum dots, electrical injection and optical spin detection and selection rules.

12. Magnetism and magnetic materials

Diamagnetism, Paramagnetism (Langevin classical theory and Brillouin quantum theory), Ferromagnetism (molecular field theory), Domain walls, Fine particles and thin films (single versus multi-domain behavior, superparamagnetism in nanoparticles and alloys), Soft and hard magnetic materials (Fe-Co alloys, rare earth magnets).

13. 2D Materials: Optical and electronic properties

Graphene, transition metal dichalcogenides, optical and electronic properties, photoluminescence, reflection, and Raman spectroscopy, spin-valley polarization, valley-electronics (valleytronics).

(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, laboratory education,*	Use of Power Point Videos with demonstration/understanding experiments. • Use of an asynchronous e-learning platform (e-class)

communication with students	where the following are provided: o *Bibliography of the course* o *Slides of the course* o *Solved and unsolved exercises* o *Self-study Exercise Set* o *Demonstration videos and simulations* o Communication through the e-class platform, use of the discussion area facility with topics, email as well as fixed office hours announced.
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*	see table below

Activity	***Semester workload***
Lectures	39
Exercises	10
Non-directed learning activity	98
Directed learning activity (office hours)	26
Writing project	74
Course total	**247**

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 completing projects in English that includes a combination of: - Written work (60%) - Public presentation (25%) - Oral examination (15%) Students have the right to view their written work 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://mscs.uoc.gr/dmst/?courses=course-b

(5) ATTACHED BIBLIOGRAPHY

- *Suggested bibliography:*

1. G.A. Ozin, A.C. Arsenault, Nanochemistry: A Chemical Approach to Nanomaterials, RSC Publishing, Cambridge, UK, 2005.
2. G. Cao, Nanostructures and Nanomaterials: Synthesis, Properties and Applications, Imperial College Press, London, UK, 2004.
3. M. Dyakonov, Spin Physics in Semiconductors, Springer Series in Solid-State Sciences 157,

Springer, 2008.
4. B.D. Cullity and C.D. Graham, Introduction to Magnetic Materials, Wiley, 2009.
5. A. R. West, Solid State Chemistry and Its Applications, Wiley, 2014.

- *Related academic journals:*
Nature Nanotechnology
Nature Materials
Nature Reviews Materials
ACS Nano
ACS Applied Nano Materials
Nano Letters
Materials Horizons
Nanoscale Horizons
Nanomaterials

MEMY-502. Theoretical Materials Science

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	MATERIALS SCIENCE AND TECHNOLOGY		
LEVEL OF STUDIES	POSTGRADUATE		
COURSE CODE	**METY-502**	**SEMESTER**	A
COURSE TITLE	**THEORETICAL 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	4	10
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*	SKILLS DEVELOPMENT, SPECIALIZED GENERAL KNOWLEDGE
PREREQUISITE COURSES:	
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	ENGLISH
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	https://mscs.uoc.gr/dmst/?courses=theoretical-materials-science

(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 an introduction to the relationship between the atomic/electronic structure of solid materials and their macroscopic properties as well as the properties that render them invaluable in modern technology. The first part of the course is basic quantum mechanics and the second part is an introduction to the basic principles of solid-state physics. The course covers topics such as the postulates of quantum mechanics and implications, the 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. The learning goals that should have been achieved by the end of the course are:

1. Students learn the basics of quantum theory of matter.
2. Students understand the role of quantum theory in the stability of solids as well as their mechanical and electronic properties.
3. Students should be able to explore the interaction of materials with electromagnetic fields.
4. Students become familiar with the most important aspects of the electronic properties of materials so that they can understand the design and operation of electronic devices.

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

(3) SYLLABUS

A) Quantum Mechanics:

1. Background:
   Waves and Particles, Hilbert space, Hermitian operators and observables, operator algebra, the postulates of Quantum mechanics.
2. The basic theorems:
   Eigenvalues of position, energy and momentum, Ehrenfest theorem, Uncertainty principle.
3. Harmonic Oscillator:
   Algebraic method, eigenstates and eigenvalues, applications.
4. Angular momentum:
   Ladder operators, eigenvalues and eigenstates for rotations and for spin, addition of angular momenta, spin-orbit coupling, singlet-triplet states.
5. Many-body systems:
   Spin-statistics theorem, Slater Determinants, Pauli principle, exchange and correlation effects, Density-Functional Theory.

B) Quantum Theory of Solids:

6. From atoms (ions – external electrons) to solids:
   Equilibrium structures at minimum energy, Coulomb potential energy and quantum kinetic energy, Heisenberg's uncertainty principle and minimum kinetic energy. Atoms size and energy, formation of molecules and solids, estimate of values for basic properties of elemental solids using fundamental principles and dimensional analysis.
7. Electron motion, the problem of electrical resistivity and the basic approximations in solid state physics:
   Drude formula. Atomic structure and bonding and the properties of solids, crystal lattices. Adiabatic (Born-Oppenheimer), independent particle, harmonic approximation. Periodicity, Bloch theorem, origin of energy bands and gaps. One-dimensional "crystals", chain of classical coupled harmonic oscillators and phonon bands.
8. Linear combination of atomic orbitals:
   Diatomic molecule. One-dimensional tight-binding model, bands and gaps for more than one orbital per atom, diatomic unit cell. Analogy with wave propagation in one-dimensional “crystals” of coupled harmonic oscillators and phonons.
9. Semiclassical theory of conduction in metals :
   Electrons in a conduction band, free electron model, Fermi energy, total (kinetic) energy, density of states, effective mass, DC conductivity, materials response to EM field, oscillators model for conductivity and dielectric function, properties and uses of dielectric function.
10. Conduction in semiconductors:
    Electrons and holes, carrier effective mass, intrinsic semiconductor conductivity, carrier mobility and concentration, temperature dependence, chemical potential and Fermi energy. Impurities, donors and acceptors, Fermi level in extrinsic semiconductors, temperature dependence, carriers lifetime.

(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. • Videos with demonstration/understanding experiments. • Use of an asynchronous e-learning platform (e-class) where the following are provided: o *Bibliography of the course* o *Slides of the course* o *Solved and unsolved exercises* o *Self-study Exercise Set* o *Lecture videos* o *Demonstration videos and simulations* o Communication through the e-class platform, use of the discussion area facility with topics, email as well as fixed office hours announced

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*	see table below

Activity	***Semester workload***
Lectures	52
Projects/Assignments	44
Non-directed learning activity	126
Directed learning activity (office hours)	26
Course total	**248**

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 short written exams or homework on a weekly basis, a written midterm exam and a written final exam 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

- Suggested bibliography::

- Eugen Merzbacher, Quantum Mechanics, 3rd Edition, John Wiley & Sons (1998).
- Stefanos Trachanas, An Introduction to Quantum Physics: A First Course for Physicists, Chemists, Materials Scientists, and Engineers, 1st Edition, Wiley-VCH (2017).
- Charles Kittel, Kittel's Introduction to Solid State Physics, Global Edition, 8th Edition, Wiley (2018)
- E.N. Economou, The Physics of Solids Essentials and Beyond, 1st Edition, Springer (2010).
- W.D. Callister, Jr., D.G. Rethwisch, Materials Science and Engineering: An Introduction, 10th Edition, Wiley (2018).
- I. Harald, L. Hans, Solid-State Physics: An Introduction to Principles of Materials Science, 4th Edition, Springer (2009).

SECOND SEMESTER – CORE COURSES

MEMY-503. Soft Matter Science and Engineering

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	MATERIALS SCIENCE AND TECHNOLOGY		
LEVEL OF STUDIES	POSTGRADUATE		
COURSE CODE	**METY-503**	**SEMESTER**	B
COURSE TITLE	**Soft Matter Science and 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	10
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*	SKILLS DEVELOPMENT, SPECIALIZED GENERAL KNOWLEDGE		
PREREQUISITE COURSES:			
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	ENGLISH		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES		
COURSE WEBSITE (URL)	https://mscs.uoc.gr/dmst/?courses=soft-mater		

(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 aim of the course is to introduce students to fundamental concepts of soft matter synthesis and physics. The course covers topics such as various synthetic routes for polymers, spectroscopic characterization of polymers and introductory polymer-colloid physics (characteristic sizes and times, thermodynamics and phase behavior, flow properties of polymers in relation to their processability). The course according to the European Qualifications Framework for Lifelong Learning belongs 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* *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…* …….
1. Understanding of basic concepts and utilization of soft materials in technological applications. 2. Critical and creative thinking with logic that combines concepts 3. Work in interdisciplinary environment that combines physical and chemical properties. 4. Individual .and autonomous projects

(3) SYLLABUS

A. Synthesis Poly-condensation polymerization and kinetics ; Free Radical Polymerization, Kinetics ; Ionic and Cationic polymerization ; Controlled Radical Polymerization ; Characterization (NMR, IR, GPC) B. Polymer Physics Main characteristic of soft matter (length, time and energy scales) ; Fractal concepts, volume fraction, overlap concentration, molecular weight distribution ; Ideal and Real polymer chains (Freely Rotating Chain, Kuhn Chain, Excluded Volume, Solvent quality) ; Thermodynamics of Polymer Solutions ; Deformation, entropic elasticity,relation of characteristic sizes to moduli ; Polymer Dynamics (Rouse, Zimm, Reptation) ; Forces and Interaction in colloidal suspensions, Brownian Motion ; Phase behaviour of Brownian Hard Spheres, Rods and Discs ; Softness: From polymers to Colloids

(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. Videos with demonstration/understanding experiments. • Use of Demonstration experiments • Use of an asynchronous e-learning platform (e-class) where the following are provided: o *Bibliography of the course* o *Slides of the course* o *Solved and unsolved exercises* o *Self-study Exercise Set* o *Lecture videos** o *Demonstration videos and simulations* *o* Communication through the e-class platform, use of the discussion area facility with topics, email as well as fixed office hours announced Students' assignments are received and corrected via the platform (e-class)
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*	(see table below)

Activity	***Semester workload***
Lectures	52
Assignments/Projects	40
Non-directed learning activity	128
Directed learning (office hours)	130
Office hours	26
Course total	**246**

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*	Language of Evaluation: English The final grade is the Course participation Quiz Project

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

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography: • <u>*Related academic journals:*</u> Macromolecules, ACS Macro Letters , Soft Matter

MEMY-504. Biomaterials and Biomedical Engineering

(1) GENERAL

SCHOOL	School of Sciences and Engineering		
ACADEMIC UNIT	Department of Materials Science and Technology		
LEVEL OF STUDIES	POSTGRADUATE		
COURSE CODE	**METY-504**	**SEMESTER**	**B**
COURSE TITLE	**Biomaterials and 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**
	4	10
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
PREREQUISITE COURSES:	
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	ENGLISH
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	https://mscs.uoc.gr/dmst/?courses=biomaterials-biomolecules

(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 outline includes the study of biomaterials and biomolecules, 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:

- To become familiar with the properties and attributes of biomaterials.
- To become familiar with biomaterial fuctionalization methodologies.
- To be able for principle-based design of biomaterials and apply them in biomedical research and medicine.
- To know the basic methods for the mathematical modelling of tissue constructs and biomedical systems.
- To understand the need of biomolecule functionalization.
- To consolidate the notions of the structural mechanisms used by Nature to create materials with defined properties.
- To use their knowledge in the design of biocompatible materials
- To be conceptually prepared to perform a Masters thesis in a research laboratory in the area of biomolecules, biomaterials, bioengineering, tissue engineering and regenerative medicine

The course according to the European Qualifications Framework for Lifelong Learning belongs 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…*

....
- 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

- Natural and synthetic biomaterials used in biomedicine (metal, metal alloys, ceramics, natural and synthetic polymers). Definitions and properties.
- Princicles of biomaterial functionalization.
- Rational design of synthetic biomaterials.,
- Principles in Tissue Engineering
- Bone, cartilage, dental, cardiovascular tissue engineering
- Cell adhesion
- Mechanical properties and biocompatibility of implantable biomaterials
- Methods & tools for mathematical modelling of tissue constructs and biomedical systems: solid mechanics, fluid mechanics, dynamic systems.
- Biofabrication methods: capabilities, technologies, hardware.
- Applications of biomaterials in 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*	Use of Power Point and e-class, Supportive learning through the use of valid online scientific tools
TEACHING METHODS *The manner and methods of teaching are described in detail.* *Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.* *The student's study hours for each learning activity are given as well*	(see table below)

Activity	***Semester workload***
Lectures	52
Projects/ Assignments	20
Non-directed learning	148
Directed learning (office hours)	26
Office hours	20
Course total	**240**

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 a final written examination in English 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:

1. Bioconjugate Techniques, Greg T. Hermanson, Academic Press, Inc., 2008
2. J. S. Temenoff, A. G. Mikos, Biomaterials: The Intersection of Biology and Materials Science, 2nd edition, Pearson, 2022.
3. C. M. Agrawal, J. L. Ong, M. R. Appleford, G. Mani, "Introduction to Biomaterials Basic Theory with Engineering Applications" Cambridge Texts in Biomedical Engineering, 2013.
4. "An Introduction to Biomaterials, Second edition" Ed. J. Hollinger, Taylors and Francis, 2012.
5. J.P. Fisher, A.G. Mikos, J.D. Bronzino "Tissue Engineering", CRC Press, 2007
6. Cindy Chung, Jason A. Burdick, Engineering cartilage tissue, Advanced Drug Delivery Reviews 60, 243–262, 2008
7. B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts, and P. Walter, "Molecular Biology of the Cell, 4th edition", Garland Science 2002, chapter 19
8. Stephanie Willerth, Shelly Sakiyama-Elbert, Stem book, Combining stem cells and biomaterial scaffolds for constructing tissues and cell delivery

- Related academic journals:

9. Tissue Engineering Part A, B & C, Mary Ann Liebert
10. Journal of Tissue Engineering and Regenerative Medicine, Wiley
11. Biomaterials, Elsevier
12. Acta Biomaterialia, Elsevier
13. Advanced Healthcare Materials, Wiley
14. Biomaterials Science and Engineering, ACS
15. Biomaterials Science, RCS
16. Biomacromolecules, ACS
17. Annals of biomedical engineering, springer
18. Nature biomedical engineering, springer
19. Nature reviews bioengineering, springer

FIRST SEMESTER – ELECTIVE COURSES

MEMY-428. Sustainable (Bio)polymers

(1) GENERAL

SCHOOL	SCHOOL OF SCIENCE AND ENGINEERING		
ACADEMIC UNIT	MATERIALS SCIENCE AND TECHNOLOGY		
LEVEL OF STUDIES	POSTGRADUATE		
COURSE CODE	**MEMY -428**	**SEMESTER**	**A**
ΤΙΤΛΟΣ ΜΑΘΗΜΑΤΟΣ	**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**
Lectures		4	7
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	special background		
PREREQUISITE COURSES	None		
LANGUAGE OF INSTRUCTION and EXAMINATIONS	English		
IS THIS COURSE OFFERED TO ERASMUS STUDENTS	YES		
COURSE WEBSITE (URL)	https://mscs.uoc.gr/dmst/?courses=sustainable-biopolymers		

(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 aims to provide up-to-date knowledge on principles of sustainability, sustainable polymers chemistry and a grasp on the design and applications of biodegradable and/or biobased plastics as an alternative to petroleum-based plastics. Upon completion of the course the students should be able to: • Understand the basic definitions and principles of sustainable polymers and biodegradable polymers, • Incorporate the principles of sustainability into polymer science concepts. • Assess the main features of polymeric materials in terms of sustainability. • Describe how biomass can be transformed into chemical building blocks and biobased polymers. • Understand how biomass can be transformed into valuable chemical synthons and polymers. • Evaluate the application and fate of polymers as a function of their chemical structure. • Incorporate innovative techniques which could potentially enhance the sustainability on lab and industrial scale (photochemistry, electrochemistry, flow chemistry…) • Work in multidisciplinary environments requiring basic polymer chemistry sustainability understanding (within the framework of a diploma thesis or Erasmus).

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 Teamwork

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…
…….

- Search, analyze and synthesize data and information, using the necessary technologies
- Adapting to new situations
- Autonomous work
- Teamwork
- Working in an interdisciplinary environment
- Generation of new research ideas
- Respect for the natural environment
- Project planning and management

(3) SYLLABUS

Polymer and biopolymer synthesis aimed to provide sustainable solutions on biotechnological applications.

1) Introduction to plastic pollution and proposed solutions: Recycling, Biodegradable polymers. (Definitions: Bio-based, Biodegradable, Compostable, Biomass, Carbon footprint, Life cycle analysis (LCA)). Basic principles of sustainable chemistry: prevention, atom economy and other sustainability metrics, use of renewable resources, safety, reduction of energy requirements.
2) Monomers (and polymers) derived from biomass: Biorefinery.
3) Natural polymers (cellulose, starch, lignin, gelatine, chitin, chitosan etc.): Structures, properties, advantages and disadvantages.
4) Bio-based, non-biodegradable polymers: polyethylene (PE), Polypropylene (PP), Polyethylene Terephthalate (PETE or PET), polyurethane (PU), polyamide (PA).
5) Petroleum-based biodegradable polymers: poly(butylene adipate-co-terephthalate) (PBAT), polycaprolactone (PCL), poly(butylene succinate (PBS).
6) Sustainable polymers from biomass: a. polylactic acid (PLA) synthesis, crystallization, properties, processing, biodegradation, applications, b. polyhydroxyalkanoates (PHAs) types, properties, synthesis, processing, applications.
7) Biocomposites, classification, natural fibers.
8) Applications of bioplastics and biocomposites: packaging, food, foams, medicine (drugs and drug delivery), personal care, textiles etc.
9) End of life options for plastics: Recycling (mechanical, chemical), composting, waste-to energy, land fill operations.
10) Environmental assessments, LCA of sustainable plastics, biodegradation standards for polymers (industrial composting, marine composting, anaerobic digestion, active landfill, home compost, solid biodegradation), determination of bio-based carbon

content.

11) Laboratory project on: synthesis of biopolymers, 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 slides • Communication through the e-class platform, use of the discussion area facility with topics, email as well as fixed office hours announced
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*	see table below

Activity	***Semester workload***
Lectures	52
Assignments/Projects	30
Directed learning activity (office hours)	26
Non-directed learning activity	66
Course total	***174***

STUDENT PERFORMANCE EVALUATION	Language of Evaluation: English The final grade is the sum of 50% Final exam 30% Laboratory Report 20% Laboratory Performance

(5) ATTACHED BIBLIOGRAPHY

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

- Sustainable Chemistry & Engineering, ASC
- Sustainable Materials and Technologies, Elsevier

MEMY-453. Crystal Chemistry

(1) GENERAL

SCHOOL	SCHOOL OF SCIENCE AND ENGINEERING		
ACADEMIC UNIT	MATERIALS SCIENCE AND TECHNOLOGY		
LEVEL OF STUDIES	POSTGRADUATE		
COURSE CODE	**METY-453**	**SEMESTER**	**A**
COURSE TITLE	**Crystal Chemistry**		

INDEPENDENT TEACHING ACTIVITIES	**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures	4	7

COURSE TYPE	special background
PREREQUISITE COURSES:	None
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	English
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	https://mscs.uoc.gr/dmst/?courses=crystal-chemistry

(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 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

Adapting to new situations Decision-making
Working independently Teamwork

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...
....

-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 <u>database of ionic radii</u>, <u>physical properties of semiconductors</u>, <u>ICSD</u>, <u>CSD</u>** **Use of visualization and analysis software of the crystal structure.**
TEACHING METHODS	

Activity	***Semester workload***
Lectures	52
Non-directed learning activity, Study bibliography at home	94
Directed learning activity (office hours)	26
Course total	***172***

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 of Evaluation: English 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

MEMY-491. Organic Materials and Synthetic Biomaterials

(1) GENERAL

SCHOOL	SCHOOL OF SCIENCE AND ENGINEERING		
ACADEMIC UNIT	MATERIALS SCIENCE AND TECHNOLOGY		
LEVEL OF STUDIES	POSTGRADUATE		
COURSE CODE	**MEMY -491**	**SEMESTER**	**A**
COURSE TITLE	**Organic Materials and Synthetic 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	7
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	None
LANGUAGE OF INSTRUCTION and EXAMINATIONS	English
IS THIS COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	https://mscs.uoc.gr/dmst/?courses=biological-materials-and-synthetic-biomaterials

(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 gives a broad overview of the field of organic and synthetic biomaterials, presenting examples of biomaterial applications in medicine but also ethical issues that arise for the development of new biomaterials.

The course according to the European Qualifications Framework for Lifelong Learning belongs 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 *Adapting to new situations Decision-making* *Working independently Teamwork* *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...* *.......*

- Work independently and in Teamwork.
- Analytical and synthetic ability to solve problems.
- Critical thinking
- Bibliographic research, analysis, synthesis and presentation of contemporary research findings.

(3) SYLLABUS

The course covers the following modules:

- Properties of materials, categories of materials used in Medicine,
- History of biomaterials,
- Examples of biomaterials in organs and systems of the body,
- The role of protein adsorption in the biological response, Cells, tissues, extracellular matrix, Cell-biomaterial interactions, Host reactions in biomaterials and their evaluation: inflammation, infection, infection, treatment, immunization, hypersensitivity, toxicity, tumorigenesis, blood clotting,
- Biological control of biomaterials: in vivo, and in vitro, compatibility,
- Degradation of materials in biological environment,
- Applications of biomaterials in orthopedics, hip and knee prosthetics,
- Dental implantation, Surgical suture threads, Implant failure,
- Ethical issues for the development of new biomaterials,
- Prospects and possibilities in Biomaterials Science

(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 slides • Communication through the e-class platform, use of the discussion area facility with topics, email as well as fixed office hours announced
TEACHING METHODS *The manner and methods of teaching are described in detail.*	

Activity	*Semester workload*
Lectures	52
Assignments/Projects	30

<table>
<tr><td>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><td>Directed learning activity (office hours)</td><td>26</td></tr><tr><td>Non-directed learning activity</td><td>66</td></tr><tr><td></td><td></td></tr><tr><td>Course total</td><td>174</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 of Evaluation: English

The final grade results from the grade in the final written examination and the grade of the assignments</td></tr>
</table>

(5) ATTACHED BIBLIOGRAPHY

Bibliography-   NOTES

MEMY-580. Optoelectronics & Laser

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	MATERIALS SCIENCE AND TECHNOLOGY		
LEVEL OF STUDIES	POSTGRADUATE		
COURSE CODE	**MEMY-580**	**SEMESTER**	**A**
COURSE TITLE	**OPTOELECTRONICS & LASER**		

INDEPENDENT TEACHING ACTIVITIES	**WEEKLY TEACHING HOURS**	**CREDITS**
	4	7

COURSE TYPE	special background
PREREQUISITE COURSES:	Without being strict prerequisites, in this course is assumed that students have been taught an introductory course in Semiconductor Physics such as ETY 242 and ETY 481, and an introductory course in Solid State Physics such as ETY 305
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	English
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	https://mscs.uoc.gr/dmst/?courses=optoelectronics-and-laser

(2) LEARNING OUTCOMES

(2) 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 combines a general overview of the field of Optoelectronics with an in-depth introduction to the operating principles of perhaps the most characteristic and exciting optoelectronic device, which is the laser diode. Special emphasis is given in handling problems of practical interest that require the use of computer and of basic computational methods.

The course according to the European Qualifications Framework for Lifelong Learning belongs 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* *Adapting to new situations Decision-making Working independently Teamwork* *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...* *.......*
Search, analyze and synthesize data and information, using the necessary technologies - Promotion of free but structured, creative and inductive thinking - Autonomous work

SYLLABUS

- Brief review of the optical properties of semiconductors, quantum wells and waveguides
- General presentation of diode lasers and other optoelectronic devices
- Conditions for lasing action
- Operating principles of diode lasers
- Special reflectors and cavities for diode lasers
- Optical gain in quantum wells
- Tunable semiconductor laser

(3) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY.	Face-to-Face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of a video projector during lectures with Power Point or pdf slides. Posting announcements and communicating with students through an e-class environment.
TEACHING METHODS	see table below

Activity	*Semester workload*
Lectures	39
Assignments/Projects	60
Directed learning activity (office hours)	10
Non-directed learning activity	66
Course total	***174***

STUDENT PERFORMANCE EVALUATION	Language of Evaluation: English The evaluation of students is done by delivering sets of exercises during the semester corresponding to 40% of the grade and a final exam in the form of a take-home exam corresponding to 60% of the grade. The book by L. Coldren and S. Corzine, is followed in the course

(4) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- L. Coldren and S. Corzine, Diode lasers and photonic integrated circuits, Wiley Series in Microwave and Opitcal Engineering, John Wiley & Sons (1995)
- P. Yeh, Optical Waves in Layered Media, Wiley Series in Pure and Applied Optics (1988)
- G. P. Agrawal and N. K. Dutta, Semiconductor Lasers, 2nd Edition, International Thomson Publishing (1993)
- J. Singh, Semiconductor Optoelectronics: Physics and Technology, McGraw-Hill (1995)

MEMY-582. Advanced Solid-State Materials and Nanostructures

(1) GENERAL

SCHOOL	SCHOOL OF SCIENCE AND ENGINEERING		
ACADEMIC UNIT	MATERIALS SCIENCE AND TECHNOLOGY		
LEVEL OF STUDIES	POSTGRADUATE		
COURSE CODE	**MEMY -582**	**SEMESTER**	**A**
COURSE TITLE	**Advanced Organic Materials for Energy and Environment**		

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	7
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	None
LANGUAGE OF INSTRUCTION and EXAMINATIONS	English
IS THIS COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	https://mscs.uoc.gr/dmst/?courses=advanced-organic-materials-for-energy-and-environment

(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 introduce students to contemporary issues of loose material, and more specifically to organic and polymeric materials of particular technological impact in the field of energy. More specifically, the course will introduce students to the basic principles of synthesis of Organic Conductive Materials (HIO), their optoelectronic properties and special emphasis will be given to the structure-properties correlation of nanostructured active

materials for their use in: 1) innovative organic solar cells, 2) electrochemical energy storage devices and 3) fuel cells. The main axis of the course is the study of new advanced energy materials, the understanding of their properties at the nanoscale and how they affect/determine their macroscopic properties as well as the understanding of the operating mechanisms of organic energy production and storage devices. The aim of the course is for students to combine existing knowledge with what they will acquire in the course in order to deepen in modern research issues the loose material for energy production and storage. In the last part of the course, students will be asked, in collaboration with the instructor, to select and present a recent research article whose performance will determine 25% of the grade. *The course according to the European Qualifications Framework for Lifelong Learning belongs 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 Adapting to new situations Decision-making Working independently Teamwork 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... ....*
- Search, analyze and synthesize data and information, using the necessary technologies - Promotion of free but structured, creative and inductive thinking - - Autonomous work

(3) SYLLABUS

The course includes: Introduction-Description and classification of Organic Conductive Materials (HIO), Optical and Optoelectronic Properties of Advanced HIO, Basic Principles of Operation of Organic Photovoltaics, Correlation of Structure – Properties of Nanostructured Active Films, Organic Electrolytes, Electrochemical Energy Storage Devices, Mechanisms of Operation of Solid Organic Electrolytes, Solid State Batteries, Basic Principles of Fuel Cell Operation, Hybrid Nanomaterial Systems for Advanced Energy Production and Storage Technologies, Advanced Materials for Batteries Other than Lithium-Ion.

(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 slides • Communication through the e-class platform, use of the discussion area facility with topics, email as well as fixed office hours announced	
TEACHING METHODS	***Activity***	***Semester workload***

<table>
<tr><td>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><td>Lectures</td><td>52</td></tr>
<tr><td>Assignments/Projects</td><td>30</td></tr>
<tr><td>Directed learning activity (office hours)</td><td>26</td></tr>
<tr><td>Non-directed learning activity</td><td>66</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Course total</td><td>174</td></tr>
<tr><td></td><td></td></tr>
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</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 of Evaluation: English

The final grade results from the presentation of a research paper and the final examination</td></tr>
</table>

(5) ATTACHED BIBLIOGRAPHY

Bibliography-

- M. Geoghegan and G. Hadziioannou, Polymer Electronics , Oxford University Press, 2013
- D. M. Santos, C.A.C Sequeira, Polymer Electrolytes, Elsevier, 2010
- M. Eikerling and A. Kulikovsky, Polymer Electrolyte Fuel Cells: Physical Principles of Materials and Operation, Taylor & Francis Group, 2015

MEMY-598. Bioorganic Nanostructures – Supramolecular Chemistry

(1) GENERAL

SCHOOL	SCHOOL OF SCIENCE AND ENGINEERING		
ACADEMIC UNIT	MATERIALS SCIENCE AND TECHNOLOGY		
LEVEL OF STUDIES	POSTGRADUATE		
COURSE CODE	**MEMY -598**	**SEMESTER**	**A**
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**
Lectures	4	7
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	None
LANGUAGE OF INSTRUCTION and EXAMINATIONS	English
IS THIS COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	https://mscs.uoc.gr/dmst/?courses=bioorganic-nanostructures-supramolecular-chemistry

(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 of supramolecular chemistry, an overview of the fundamental interactions governing self-assembly and its application to living organisms and synthetic nanostructures, and finally a first consideration of current trends in the design of supramolecular assemblies and devices based on current literature. *The course according to the European Qualifications Framework for Lifelong Learning belongs 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 Adapting to new situations Decision-making Working independently Teamwork 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... ....

- Autonomous work
- Teamwork
- Working in an interdisciplinary environment
- Generation of new research ideas
- Promoting free, creative and inductive thinking

(3) SYLLABUS

The course provides an analytical first overview of supramolecular chemistry and methods for the construction of self-organizing (bio)nanostructures. It aims at understanding the principles of supramolecular chemistry of intermolecular interactions that determine the formation of supramolecular structures. The fundamental interactions of self-organizing host-guest systems and functional supramolecular devices are analyzed using examples from nature and modern scientific literature. The most important approaches to the design of supramolecular systems are presented along with their properties and functions.

1. Nanotechnology: definition, approaches, perspectives.
2. Supramolecular chemistry: Definition and basic principles. Self-organization.
3. Intermolecular interactions. Self-organization: Amphiphilic molecules. Polymers, helical polymers, supramolecular polymers. Peptides. Proteins. Oligonucleotides.

(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 slides • Communication through the e-class platform, use of the discussion area facility with topics, email as well as fixed office hours announced
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.*	see table below

Activity	*Semester workload*
Lectures	39
Assignments/Projects	40
Directed learning activity (office hours)	26
Non-directed learning activity	66
Course total	***175***

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 of Evaluation: English The final grade is the sum of Oral presentation 70% Quizes 15% Final Examination 15%

(5) ATTACHED BIBLIOGRAPHY

Bibliography-

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

MEMY-901. Foundations of Modern Optics

(1) GENERAL

SCHOOL	SCHOOL OF SCIENCE AND ENGINEERING		
ACADEMIC UNIT	MATERIALS SCIENCE AND TECHNOLOGY		
LEVEL OF STUDIES	POSTGRADUATE		
COURSE CODE	**MEMY -901**	**SEMESTER**	**A**
ΤΙΤΛΟΣ ΜΑΘΗΜΑΤΟΣ	**Foundations of Modern Optics**		

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	7
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	None
LANGUAGE OF INSTRUCTION and EXAMINATIONS	English
IS THIS COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	https://mscs.uoc.gr/dmst/?courses=foundations-of-modern-optics-2

(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 able to:

- Be familiar with the basic principles of optics.
- Be familiar with the principles of electromagnetism with emphasis on their application to optics.
- Be familiar with the basic principles governing wave propagation, the description of

transverse E/M waves in various media and the phenomena of contribution and diffraction.

- Be able to describe in detail the polarization of optical waves as they are imparted to complex optical devices.
- To know the principles of operation and design of imaging optical systems and to solve problems of designing optical light systems within complex optical systems.
- Be able to independently describe and solve optical design problems.

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 Teamwork

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…
…….

- Capacity to address complex problems.
- Development of scientific thought
- Use of the University Library and multiple bibliographic references
- Searching sources, simulations, and electronic courses on the internet
- Taking notes and development of independent methods of studying
- Writing research reports
- Efficient management of time and deadlines
- Development of the ability to present concepts in a succinct form

(3) SYLLABUS

The syllabus covers the following topics organized in the following 4 units:

1. **Introduction:** *Historical introduction, Waves: harmonic waves, longitudinal, transverse, complex description, phase velocity, wave front types.*
2. **Fundamentals:** *Electromagnetism, Maxwell's equations: wave equation, velocity of wave propagation, Poynting vector, radiation intensity. Spectrum of electromagnetic radiation, refractive index, dispersion – absorption, classical dispersion theory*
   a) ***Detection of radiation:*** *The photoelectric effect, photomultipliers, photoresistors, photodiodes, phototransistors, CDD detectors, film Photometry – Radiometry*
   b) ***Sources of radiation:*** *Black body radiation, incandescent, arc, spectral gas, fluorescence lamps, LEDs, LASERs: basic principles, pumping – amplification of light, laser cavity, gas lasers, solid state lasers, diode lasers*
   c) ***Polarization:*** *Polarization state, degree of polarization, non polarized light. Linear, elliptical, circular polarization, Jones vectors and matrices, Stokes parameters and Mueller matrices, Linear polarizers, retardation plates. Birefringence: birefringent crystals, the dielectric tensor, refractive index ellipsoid, wavefront surface, eigen polarizations, optical activity, Polarization by scattering, Polarization by reflection, evanescent waves*
   d) ***Interference:*** *Group velocity, coherence, interference conditions, types and localization of interference fringes Two wave interference, multiple plane wave interference, Wavefront splitting interferometers: Young's experiment, Amplitude splitting interferometers: Equal inclination fringes (thin film interference), Equal thickness fringes, interference under multiple reflections.*

3. **Imaging:**
   a) ***Geometrical optics:*** *Optical rays, the geometrical optics approximation,The concept of Imaging, stigmatic imaging, Reflection, Refraction (Snell equation), total internal reflection, Reflectivity (Fresnel coefficients), Fermat's principle, application in reflection and refraction, Reflection prisms, Dispersion prisms: minimum deviation, monochromators*
   b) ***Simple optical systems:*** *Reflection from plane mirror, retro-reflectors. Refraction from a plane interface, propagation through a transparent plate, Spherical interfaces, Spherical lenses, Spherical mirrors. Paraxial approximation, Imaging with thin lenses and mirrors, the use of cardinal points, examples, 3D objects, Magnification*
   c) ***The matrix method:*** *The ray vector. Ray translation, refraction, reflection matrices, matrix of an optical system, estimation of cardinal points, imaging using matrices, optical system composition (equal subsystems, symmetrical systems, magnification, Basic principles of analysis and design of optical systems using ray matrices*
   d) ***Image illumination:*** *aperture stop, field stop, entrance-exit pupil, entrance-exit window, telecentric systems.*
   e) ***Optical Abberations:*** *ray aberration, wavefront aberration, Monochromatic aberrations. Seidel primary aberrations: spherical, comma, astigmatism, field curvature, distortion. Chromatic aberrations: longitudinal -transverse, Sphero- chromatic. Achromatic lenses, apochromatic lenses, aspherical lenses*
   f) ***Eikonal equation :*** *Optical rays, Derivation of the eiconal equation, geometrical wave surfaces, ray* equation, paraxial approximation Propagation in inhomogeneous media.
4. **Wave propagation:**
   (2) **Diffraction:** *Fresnel zones, Helmloltz-Kirchhoff integral theorem, Kirchhoff diffraction theory. Fraunhofer and Fresnel diffraction: slit, rectangular, circular opening. Resolution, diffraction limited systems. Array of diffracting openings: multiple slits*
   (3) **Gaussian beams:** *Propagation, beam waist, confocal parameter. Imaging of Gaussian beams, matrix description*

(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 slides • Videos with demonstration/understanding experiments. • Demonstration experiments of basic optical phenomena • Use of an asynchronous e-learning platform (e-class) where the following are provided: o *Bibliography of the course* o *Slides of the course** o *Solved and unsolved exercises** o *Self-study Exercise Set* o *Lecture videos** o *Demonstration videos and simulations** o *Operating code for wave propagation simulations*

(The code has been developed for the needs of the course on a free software platform)

- Communication through the e-class platform, use of the discussion area facility with topics, email as well as fixed office hours announced
- Students' assignments are received and corrected via the platform (e-class)

* *Creative Commons CC-BY-ND-3.0 licenses*

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
Assignments/Projects	30
Directed learning activity (office hours)	26
Non-directed learning activity	66
Course total	***174***

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 of Evaluation: English

The final grade is the sum of the following grades:

40% of the average of the grades of the weekly assignments

30% of the average of the grades of the weekly written tests

30% of the grade of the final written examination

(5) ATTACHED BIBLIOGRAPHY

- *Lecture notes*
- *"Optics", E. Hecht, Addison-Wesley, (2001).*
- *"Principles of Optics", M. Born, E. Wolf.*
- *"Introduction to Modern Optics", G.R. Fowles, Dover, (1989).*
- *"Introduction to Fourier Optics", J. W. Goodman, McGraw-Hill, (1996).*

Bibliography: exercises with solutions

- *"Solved exercises in Optics"*, *D. Papazoglou, UoC, (2022).*

SECOND SEMESTER – ELECTIVE COURSES

MEMY-446. Transmission Electron Microscopy

2) GENERAL

SCHOOL	SCHOOL OF SCIENCE AND ENGINEERING		
ACADEMIC UNIT	MATERIALS SCIENCE AND TECHNOLOGY		
LEVEL OF STUDIES	POSTGRADUATE		
COURSE CODE	**MEMY -446**	**SEMESTER**	**B**
ΤΙΤΛΟΣ ΜΑΘΗΜΑΤΟΣ	Transmission Electron Microscopy		

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	7
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	None
LANGUAGE OF INSTRUCTION and EXAMINATIONS	English
IS THIS COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	https://mscs.uoc.gr/dmst/?courses=transmission-electron-microscopy

(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*

- Introduction to the basic principles governing electron scattering and the operation of electromagnetic lenses.
- To prepare students to understand the basic principles that characterize the electron microscopy, electron scattering and diffraction, and imaging.

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

Adapting to new situations Decision-making
Working independently Teamwork

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

- Production of free, creative and inductive thinking

(3) SYLLABUS

This course includes an introduction to the basic principles of electron microscopy with emphasis on scanning electron microscopy (SEM) and transmission electron microscopy (TEM). The principles of electron microscopy and electromagnetic lenses are described.

A. Principles of the TEM

1. Introduction to TEM

History of TEM. Electron vs. light microscopy.

2. Electron Scattering and Diffraction

Coherent and incoherent scattering. Elastic and inelastic scattering.

3. Optical Theory and Electron Lenses

Resolution. Electromagnetic lens. Electrostatic lens.

B. Design of the TEM

4. Electron Guns and Electron lenses

Thermionic guns and field-emission guns (FEGs). Condenser, objective and projector lens. Apertures and diaphragms. Lens aberrations (spherical aberration, chromatic aberration and astigmatism). Depth of focus and depth of field.

5. Imaging System

Electron detectors. Image recording.

6. Vacuum Systems

Mechanical pump. Diffusion pump. Sputter-ion pump. Turbomolecular pump.

C. Other modes on TEM
7. X-ray microanalysis
X-ray formation. Energy-dispersive X-ray spectroscopy.

8. Electron diffraction
Atomic scattering factor. Diffraction by crystals and Bragg's law. Camera length and camera constant. Producing the diffraction pattern.

D. Sample preparation
9. Specimens' preparation for materials science
Specimen support grids. Creating thin disks (Electropolishing, Ion Milling). Microtomy.

(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 slides • Videos with demonstration/understanding experiments. • Demonstration experiments • Use of an asynchronous e-learning platform (e-class) where the following are provided: o *Bibliography of the course* o *Slides of the course* • Communication through the e-class platform, use of the discussion area facility with topics, email as well as fixed office hours announced
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*	see table below
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*	Students are evaluated by final written examination in English 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.

Activity	*Semester workload*
Lectures	39
Educational visits	6
Directed learning activity (office hours)	36
Non-directed learning activity	93
Course total	**174**

Specifically defined evaluation criteria are given, and if and where they are accessible to students.	The evaluation process of the students is described during the first lecture and presented on the web site of the course.

(5) ATTACHED BIBLIOGRAPHY

Bibliography

1) D.B. Williams, C.B. Carter, Transmission Electron Microscopy: A Textbook for Materials Science, Plenum Press, New York, 1996.

2) Brent Fultz, James M. Howe. Transmission Electron Microscopy and Diffractometry of Materials, 3rd Ed., Springer, Berlin, 2008

MEMY-447. Computational Materials Science

(1) GENERAL

SCHOOL	SCHOOL OF SCIENCE AND ENGINEERING		
ACADEMIC UNIT	MATERIALS SCIENCE AND TECHNOLOGY		
LEVEL OF STUDIES	POSTGRADUATE		
COURSE CODE	**MEMY -447**	**SEMESTER**	**B**
ΤΙΤΛΟΣ ΜΑΘΗΜΑΤΟΣ	Computational 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	4	7
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, SPECIALIZED GENERAL KNOWLEDGE
PREREQUISITE COURSES	None
LANGUAGE OF INSTRUCTION and EXAMINATIONS	English
IS THIS COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	https://mscs.uoc.gr/dmst/?courses=computational-materials-science

(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 introduces the basic techniques used for the theoretical study of materials using computers. The course combines lectures and laboratory exercises in order for the students to get 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. The learning goals that should be achieved by the end of the course are:

1. Students acquire a fundamental background in state-of-the-art programming, modelling and simulation of materials.

2. Students develop scientific computing and software related technical skills.

3. Students 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 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

Adapting to new situations Decision-making
Working independently Teamwork

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...
....

- 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. Mesoscopic and continuum simulations

Coarse-grain method. Space discretization. Finite difference and finite element methods. Applications (e.g., dislocation dynamics, electromagnetic wave propagation). Cellular automata.

7. Combining methods

Concurrent and hierarchical combination of models. Multiple scale simulations.

(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 slides • Videos with demonstration/understanding experiments. • Demonstration experiments • Use of an asynchronous e-learning platform (e-class) where the following are provided: o *Bibliography of the course* o *Slides of the course** o *Solved and unsolved exercises** o *Self-study Exercise Set* o *Lecture videos** o *Demonstration videos and simulations** o Communication through the e-class platform, use of the discussion area facility with topics, email as well as fixed office hours announced • Students' assignments are received and corrected via the platform (e-class)
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*	see table below

Activity	*Semester workload*
Lectures	52
Assignments/Projects	30
Directed learning activity (office hours)	26
Non-directed learning activity	66
Course total	***174***

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 of Evaluation: English 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

Bibliography-

- 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).

MEMY-450. Polymer Physics

(1) GENERAL

SCHOOL	SCHOOL OF SCIENCE AND ENGINEERING		
ACADEMIC UNIT	MATERIALS SCIENCE AND TECHNOLOGY		
LEVEL OF STUDIES	POSTGRADUATE		
COURSE CODE	**MEMY -450**	**SEMESTER**	**B**
ΤΙΤΛΟΣ ΜΑΘΗΜΑΤΟΣ	**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**
Lectures	4	7
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	None
LANGUAGE OF INSTRUCTION and EXAMINATIONS	English
IS THIS COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	https://mscs.uoc.gr/dmst/?courses=polymer-physics

(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 students are expected to become familiar with basic concepts of polymer physics and the relation between molecular structure and properties

They are also expected to solve problems related to properties of polymers (size, structure, characteristic times, phase diagrams)

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

Adapting to new situations Decision-making Working independently Teamwork

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...
....

1. Understanding of main physical characteristics of macromolecules and their use in applications and biological relevance
2. Critical and creative thinking
3. Work in interdisciplinary environment that combines physical properties and understanding of molecular characteristics.
4. Individual .and autonomous projects

(3) SYLLABUS

The course covers the following modules:
Macromolecules and macromolecular sizes
Macromolecular time and length scale, Glass, crystal, rubber, melt.
Polymer chain statistics, Chain elasticity
Solutions and solvent quality.
Phase diagrams , Polymeric mixtures
Networks and gels
Macromolecular motion. Coarse graining. Viscoelasticity and diffusion
Molecular models: Short chains: dumbbell, Rouse, Zimm. Flow and diffusion predictions. Dynamic structure factor. Dynamic light scattering, Mechanical spectroscopy and time-temperature superposition, Long chains – entanglements. Reptation and model of deGennes–Doi–Edwards, Solutions: dilute, semi-dilute, dense.

Special topics

(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 eon, communication with students*	• Use of slides • Videos with demonstration/understanding experiments. • Demonstration experiments • Use of an asynchronous e-learning platform (e-class) where the following are provided: o *Bibliography of the course* o *Slides of the course* o *Solved and unsolved exercises*

	o Self-study Exercise Set *o Lecture videos** *o Demonstration videos and simulations* *o* Communication through the e-class platform, use of the discussion area facility with topics, email as well as fixed office hours announced • Students' assignments are received and corrected via the platform (e-class)
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*	(see table below)

Activity	***Semester workload***
Lectures	52
Assignments/Projects	30
Directed learning activity (office hours)	26
Non-directed learning activity	66
Course total	***174***

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 of Evaluation: English The final grade is the sum of Course participation Quiz and homework problems Individual projects Final exam

(5) ATTACHED BIBLIOGRAPHY

Bibliography-

M. Rubinstein, R. H. Colby, Polymer physics, Oxford, 2003

• <u>*Related academic journals:*</u>

Macromolecules, ACS Macro Letters , Soft Matter

MEMY-452. Polymer Synthesis

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	MATERIALS SCIENCE AND TECHNOLOGY		
LEVEL OF STUDIES	POSTGRADUATE		
COURSE CODE	**MEMY-452**	**SEMESTER**	**B**
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	7
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, Specialized
PREREQUISITE COURSES:	MATERIALS II: POLYMERS & COLLOIDS (ETY-243)
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	English
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	https://www.materials.uoc.gr/el/undergrad/courses/ETY452/

(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*
In this course the basic polymerization methods used in polymer synthesis are described. The mechanisms of the polymerisation methods and the kinetics of the reactions are discussed in detail. The effect of the reaction kinetics on the reaction rate and the polymer characteristics are also discussed. Finally, the basic macromolecular characterization techniques are presented. The students choose contemporary research topics in polymer synthesis for presentation (Project-Compulsory).

The learning objectives of the course are the following:

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

- Consolidate the basic principles of the polymerization kinetics and be able to predict the macromolecular characteristics.

- Familiarize the students with the macromolecular characterization techniques

- Gain experience in studying the international scientific literature and present scientific topics

The course according to the European Qualifications Framework for Lifelong Learning belongs 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…*
	…….

- Development of interdisciplinary and critical thinking

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

- Working independently

- Team work

- Project planning and management

- Production of free, creative and inductive thinking

(3) SYLLABUS

1. Basic Concepts – Polymer Nomenclature
2. Classification of polymers
3. Polymer Microstructure: Monomer architecture, orientation, tacticity, isomers
4. Average molecular weights - Properties
5. Size and shape of macromolecules
6. Types of polymerization reactions
7. Condensation or step-growth polymerization
    - Type of step reactions
    - Molecular weight and polydispersity
    - Kinetics of condensation polymerization
    - Examples
    - Industrial methods of condensation polymerization

1. Addition of Chain-growth Polymerization

- Free-radical polymerization
- Mechanism of free-radical polymerization
- Molecular weight and polydispersity
- Kinetics of free-radical polymerization
- Examples
- Industrial methods of free-radical polymerization
- Copolymerization
- Copolymerization Kinetics

2. Anionic Polymerization
    - Mechanism of anionic polymerization
    - Molecular weight and polydispersity
    - Kinetics of anionic polymerization
    - Macromolecular architectures accessible via anionic polymerization

3. Group Transfer Polymerization

4. Cationic Polymerization
    - Mechanism of cationic polymerization
    - Molecular weight and polydispersity
    - Kinetics of cationic polymerization
5. Polymer modification reactions

6. Polymer Characterization
    - Determination of molecular weight and molecular weight distribution
    - Determination of polymer composition
    - Determination of polymer tacticity

(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, communication via the departmental website and e-mail. Use of valid online scientific sources to find references and present related topics to the 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*	see table below
STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure*	The students are evaluated via 4 sets of exercises (one on each polymerization method) during the semester, a final written examination in Greek, which includes a combination of problem solving and questions on developing related topics,

Activity	***Semester workload***
Lectures	39
Exercises	16
Homework study	60
Assignments/Projects	24
Directed learning activity (office hours)	26
	114
Course total	39

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.*	and a project/presentation on a related topic from the international literature at the end of the semester. Students with learning disabilities are examined orally. The students have the right to check their exam script after the grades are announced and ask the tutor questions on the exam. The evaluation process is presented in detail to the students orally and in written form, together with the course syllabus, during the first lecture and is uploaded on the course web site: https://www.materials.uoc.gr/el/undergrad/courses/ETY452/

(5) ATTACHED BIBLIOGRAPHY

- *Suggested bibliography:*

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

- *Additional bibliography:*

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

- *Related academic journals:*

13. Macromolecules, American Chemical Society
14. Polymer Chemistry, Royal Society of Chemistry
15. Langmuir, American Chemical Society
16. Chemistry of Materials, American Chemical Society
17. Biomacromolecules, American Chemical Society
18. Advanced Materials, Wiley
19. Advances in Polymer Science, Springer-Verlag
20. Polymer, Elsevier
21. Journal of Colloid and Interface Science, Elsevier
22. Journal of Material Chemistry, Royal Society of Chemistry
23. Journal of the American Chemical Society, American Chemical Society

24. Angewandte Chemie International Edition, Wiley

MEMY-456. Rheology and Polymer Processing Processes

(1) GENERAL

SCHOOL	SCHOOL OF SCIENCE AND ENGINEERING		
ACADEMIC UNIT	MATERIALS SCIENCE AND TECHNOLOGY		
LEVEL OF STUDIES	POSTGRADUATE		
COURSE CODE	**MEMY -456**	**SEMESTER**	**B**
ΤΙΤΛΟΣ ΜΑΘΗΜΑΤΟΣ	Rheology and Polymer Processing 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	4	7
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	None
LANGUAGE OF INSTRUCTION and EXAMINATIONS	English
IS THIS COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	https://mscs.uoc.gr/dmst/?courses=1161

(2) 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 students are expected to obtain familiarity with basic concepts in rheology and processing of materials, and the different rheological phenomena and processes

They are also expected to solve problems in processing, using appropriate assumptions, and also to understand the pertinent experimental data.

The course according to the European Qualifications Framework for Lifelong Learning belongs 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* *Adapting to new situations Decision-making* *Working independently Teamwork* *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...* *.......*
1. Understanding of basics concepts and use of rheology in materials processing. 2. Critical and cretative thinking 3. Analysis of problems, use of assumptions, abstract thinking. 4. Individual and autonomous project

(3) SYLLABUS

The course covers the following modules: • Non-Newtonian fluids and linear viscoelasticity. • Constitutive Equations and nonlinear phenomena. • Introduction to polymer processing. Flow of polymeric melts in pipelines. • Examples of polymer processing (film blowing, extrusion, calendering, injection molding). • Solution of flow problems • Energy balances • Special topics o

(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 slides • Videos with demonstration/understanding experiments. • Demonstration experiments • Use of an asynchronous e-learning platform (e-class) where the following are provided: o *Bibliography of the course* o *Slides of the course* o *Solved and unsolved exercises* o *Self-study Exercise Set* o *Lecture videos** o *Demonstration videos and simulations* o Communication through the e-class platform, use of the discussion area facility with topics, email as

	well as fixed office hours announced • Students' assignments are received and corrected via the platform (e-class)
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*	see table below
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 of Evaluation: English The final grade is the sum of Course participation Quiz and homework problems Individual project Final exam

Activity	*Semester workload*
Lectures	52
Assignments/Projects	30
Directed learning activity (office hours)	26
Non-directed learning activity	66
Course total	***174***

(5) ATTACHED BIBLIOGRAPHY

Bibliography-

Related academic journals:

Journal of Rheology, Rheologica Acta, Journal of Non-Newtonian Fluid Mechanics, Physics of Fluids

MEMY-471. Elements of Colloidal Dispersions

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	MATERIALS SCIENCE AND TECHNOLOGY		
LEVEL OF STUDIES	POSTGRADUATE		
COURSE CODE	**METY-471**	**SEMESTER**	**A**
COURSE TITLE	**Elements of Colloidal Dispersions**		

INDEPENDENT TEACHING ACTIVITIES	**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures	4	7

COURSE TYPE	special background
PREREQUISITE COURSES:	None
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	English
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	https://mscs.uoc.gr/dmst/?courses=elements-of-colloidal-dispersions

(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 4. Effects of Hydrodynamic Interactions on the dynamics and their volume fraction

dependence

The course according to the European Qualifications Framework for Lifelong Learning belongs 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 *Adapting to new situations Decision-making Working independently Teamwork* *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 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

Presentation of a research topic or recent break through study or modern application of colloidal systems

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY.	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 Communication through the e-class platform, use of the discussion area facility with topics, email as well as fixed office hours announced
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*	see table below

Activity	***Semester workload***
Lectures	52
Directed learning activity (office hours)	26
Non-directed learning activity	95
Σύνολο Μαθήματος	***173***

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 of Evaluation: English Students are evaluated by a final written that includes a combination of: - Questions on theory - Exercises including calculations Oral exam is foreseen for students with specific learning difficulties -Presentation from graduate students (bonus 20%) - 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

MEMY-483. Fundamentals of Magnetic Materials

(4) GENERAL

SCHOOL	SCHOOL OF SCIENCE AND ENGINEERING		
ACADEMIC UNIT	MATERIALS SCIENCE AND TECHNOLOGY		
LEVEL OF STUDIES	POSTGRADUATE		
COURSE CODE	**MEMY -483**	**SEMESTER**	**B**
COURSE TITLE	**Fundamentals of 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**
Lectures	4	7
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	None
LANGUAGE OF INSTRUCTION and EXAMINATIONS	English
IS THIS COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	https://mscs.uoc.gr/dmst/?courses=fundamentals-of-magnetic-materials

(2) LEARNING OUTCOMES

Learning outcomes

The course combines a general overview of the field of nanotechnology of Magnetic Materials with an in-depth introduction to the basic principles of Applied Magnetism. Special emphasis is given in methods of characterization and applications of magnetic materials in cutting edge technologies and devices.

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 7.

General Competences

- Development of interdisciplinary and critical thinking
- Analysis and synthesis of data and information, with the use of the necessary technology
- Ability to conduct independent research

(3) SYLLABUS

- Magnetostatics
- Methods of magnetic measurements
- Magnetic domains
- Ferromagnetic particles
- Thin films
- Applications of ferromagnetic materials
- Magnetic recording technology

(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 slides • Use of an asynchronous e-learning platform (e-class) where the following are provided: o *Bibliography of the course* o *Slides of the course* o *Solved and unsolved exercises* o Communication through the e-class platform, use of the discussion area facility with topics, email as well as fixed office hours announced
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*	(see table below)
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*	Language of Evaluation: English The evaluation is based on a short exam during the semester, a report and oral presentation on a project and a final exam at the end of the semester.

Activity	***Semester workload***
Lectures	39
Assignments/Projects	35
Directed learning activity (office hours)	26
Non-directed learning activity	65
Course total	***165***

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

(5) ATTACHED BIBLIOGRAPHY

Bibliography-

- *D. Jiles, Introduction to Magnetism and Magnetic Materials, Chapman & Hall (1991).*
- *B.D. Cullity, Introduction to Magnetic Materials, Addison Wesley (1972).*
- *J.M.D. Coey, Magnetism and Magnetic Materials, Cambridge Univ. Press (2012)*

MEMY-490. Photonic Materials and Devices

(1) GENERAL

SCHOOL	SCHOOL OF SCIENCES & ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIAL SCIENCE AND TECHNOLOGY		
LEVEL OF STUDIES	POSTGRADUATE		
COURSE CODE	**MEMY-490**	**SEMESTER**	**B**
COURSE TITLE	**Photonic 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**
Credits awarded for the whole course (lectures and practice)	4	7
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:	A good knowledge of Electromagnetism and/or Optics is recommended.
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	English
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	https://mscs.uoc.gr/dmst/?courses=photonic-materials

(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*
Elective postgraduate course that gives a broad view of the field of Photonics, with emphasis on modern applications, like in telecommunications and nano-photonics.
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…* *…….*
Autonomous and group work. Analytic and synthetic ability for solving complex problems. Critical thinking. Bibliographic study, analysis, synthesis and presentation of modern research work.	

(3) SYLLABUS

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

(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 Use of slides • Communication through the e-class platform, use of the discussion area facility with topics, email as well as fixed office hours announced
TEACHING METHODS *The manner and methods of teaching are*	

Activity	*Semester workload*
Lectures	52

<table>
<tr><td>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><td>Assignments/Projects</td><td>30</td></tr>
<tr><td>Directed learning activity (office hours)</td><td>26</td></tr>
<tr><td>Non-directed learning activity</td><td>66</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Course total</td><td>174</td></tr>
<tr><td></td><td></td></tr>
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</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 of Evaluation: English

The final grade is the sum of

:

Written exam 40%,

Research project 60%.</td></tr>
</table>

(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*

MEMY-496. Tissue Engineering

(1) GENERAL

SCHOOL	SCHOOL OF SCIENCE AND ENGINEERING		
ACADEMIC UNIT	MATERIALS SCIENCE AND TECHNOLOGY		
LEVEL OF STUDIES	POSTGRADUATE		
COURSE CODE	**MEMY -496**	**SEMESTER**	**B**
COURSE TITLE	**Tissue Engineering**		
INDEPENDENT TEACHING ACTIVITIES		**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures		4	7
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	special background		
PREREQUISITE COURSES	None		
LANGUAGE OF INSTRUCTION and EXAMINATIONS	English		
IS THIS COURSE OFFERED TO ERASMUS STUDENTS	YES		
COURSE WEBSITE (URL)	https://mscs.uoc.gr/dmst/?courses=tissue-engineering		

(2) LEARNING OUTCOMES

Learning outcomes
To get acquainted with the structure of various tissues, organs and organ systems. *To get acquainted with basic principles of developmental biology.* *To know the components of tissue constructs: biomaterials, cells and bioactive molecules.* *To know the various types of biomaterials utilized in tissue engineering.* *To know the basic biology and applications of stem cells in tissue engineering.* *To know the basic biofabrication methods utilized in tissue engineering.* *To know the basic principles of mechanics (solid mechanics, fluid mechanics, dynamics) that describe tissue constructs.* *To know the major experimental means used for tissue construct characterization.* *Exposure to the state of the art of the major applications of tissue engineering: emphasis on regenerative medicine grafts, drug delivery systems, in vitro tissue models.*
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 Teamwork 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... ....*
Find, read and analyze recent scientific literature. *Work in teams.* *Working in an interdisciplinary environment.*

(3) SYLLABUS

The course covers the following modules:

- Structure of tissues, organs and organ systems. Case studies.
- Introduction – major concepts of tissue engineering.
- Biomaterials in tissue engineering: types, fabrication, characteristics, modification, characterization, case studies.
- Stem cells in tissue engineering: types, characterization, case studies.
- Drug delivery systems.
- Biofabrication: methods, hardware, case studies.
- Mathematic modelling in tissue engineering: solid mechanics, fluid mechanics, dynamic systems. Overview of relevant software.
- Applications of tissue engineering in regenerative medicine: cases of induced regeneration in the therapy of tissue loss or organ function loss.
- Applications of tissue engineering in drug delivery: concepts, technologies, characterization, case studies.
- Applications of tissue engineering in *in vitro* tissue organs: types, technologies, case studies.

(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 slides • Reading and discussion on published research papers. • Use of an asynchronous e-learning platform (e-class) where the following are provided: o *Bibliography of the course* o *Slides of the course* o *Research papers and scientific articles.* *o* Communication through the e-class platform, use of the discussion area facility with topics, email as well as fixed office hours announced

	• Students' assignments are received and corrected via the platform (e-class)
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*	see table below
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 of Evaluation: English The final grade is the sum of 1) final exam that includes multiple-choice questionnaires and short-answer questions, 2) class participation, 3) oral presentation and examination of semester project.

Activity	***Semester workload***
Lectures	52
Assignments/Projects	30
Directed learning activity (office hours)	26
Non-directed learning activity	66
Course total	***174***

(5) ATTACHED BIBLIOGRAPHY

Bibliography-

J.P. Fisher, A.G. Mikos, J.D. Bronzino "Tissue Engineering", CRC Press, 2007.

MEMY-512. Computational Materials Science II

(1) GENERAL

SCHOOL	SCHOOL OF SCIENCE AND ENGINEERING		
ACADEMIC UNIT	MATERIALS SCIENCE AND TECHNOLOGY		
LEVEL OF STUDIES	POSTGRADUATE		
COURSE CODE	**MEMY -512**	**SEMESTER**	**B**
COURSE TITLE	**Computational Materials Science 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**
Lectures	4	7
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	None
LANGUAGE OF INSTRUCTION and EXAMINATIONS	English
IS THIS COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	

(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:

- Become familiar with the modern theory of electronic structure, and more specifically with DFT (Density Functional Theory), by employing large software packages.
- 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.

- Develop scientific computing and software related technical skills.
- 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 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

Adapting to new situations Decision-making
Working independently Teamwork

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...
....

- 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. 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_2 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.

(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,*	• Use of slides • Videos with demonstration/understanding experiments. • Use of an asynchronous e-learning platform (e-class) where

communication with students	the following are provided: o *Bibliography of the course* o *Slides of the course* o *Solved and unsolved exercises* o *Self-study Exercise Set* o *Lecture videos*[*] o *Demonstration videos and simulations* o Communication through the e-class platform, use of the discussion area facility with topics, email as well as fixed office hours announced • Students' assignments are received and corrected via the platform (e-class)
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*	see workload table below
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 of Evaluation: English 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.

Activity	*Semester workload*
Lectures	52
Assignments/Projects	30
Directed learning activity (office hours)	26
Non-directed learning activity	66
Course total	***174***

(5) ATTACHED BIBLIOGRAPHY

Bibliography-

- *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*

MEMY-902. Optical Engineering and Metrology

(1) GENERAL

SCHOOL	SCHOOL OF SCIENCE AND ENGINEERING		
ACADEMIC UNIT	MATERIALS SCIENCE AND TECHNOLOGY		
LEVEL OF STUDIES	POSTGRADUATE		
COURSE CODE	**MEMY -902**	**SEMESTER**	**B**
ΤΙΤΛΟΣ ΜΑΘΗΜΑΤΟΣ	**Optical Engineering and Metrology**		
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	7
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	None		
LANGUAGE OF INSTRUCTION and EXAMINATIONS	English		
IS THIS COURSE OFFERED TO ERASMUS STUDENTS	YES		
COURSE WEBSITE (URL)	https://mscs.uoc.gr/dmst/?courses=foundations-of-modern-optics-2		

(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 able to:

- Become familiar with the basic principles of Optical Mechanics and Metrology.
- Know the basic principles and become familiar with the design of simple optical systems.
- Know and use computational methods and tools to study wave propagation phenomena.
- To know the principles of operation of the basic metrological applications of optics.

- Be able to autonomously describe and solve problems of optical metrology and mechanics

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 Teamwork

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…
....

- Capacity to address complex problems.
- Development of scientific thought
- Use of the University Library and multiple bibliographic references
- Searching sources, simulations, and electronic courses on the internet
- Taking notes and development of independent methods of studying
- Writing research reports
- Efficient management of time and deadlines
- Development of the ability to present concepts in a succinct form

(3) SYLLABUS

The course covers the following topics organized into modules as follows:

1) **Basic principles of analysis and design of optical systems**
   Lighting, *Image quality*, *Imaging errors*, *Computer optical design (raytracing)*
2) **Wave propagation**:
   Computational methods of wave propagation, *Angular spectrum*, *Numerical solutions and examples*,
3) **Optical Metrology**:
   a. *Methods: Interferometry*, *Spectroscopic Interferometry*, *Holography*, *Spectroscopy*
   b. *Applications: Characterization of materials*, *Surface topology*, *Optical radar*, *Distribution measurement of refractive index*, *concentration.*
4) **Wave front modulation**:
   Spatial modulators, *Creation of complex wavepackets*, *applications*

(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 slides • Videos with demonstration/understanding experiments. • Demonstration experiments of basic optical

	phenomena • Use of an asynchronous e-learning platform (e-class) where the following are provided: o *Bibliography of the course* o *Slides of the course* o *Solved and unsolved exercises** o *Self-study Exercise Set* o *Lecture videos* o *Demonstration videos and simulations** o *Operating code for wave propagation simulations* *(The code has been developed for the needs of the course on a free software platform)* • Communication through the e-class platform, use of the discussion area facility with topics, email as well as fixed office hours announced • Students' assignments are received and corrected via the platform (e-class) * *Creative Commons CC-BY-ND-4.0 licenses*
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*	see table below
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*	Language of Evaluation: English The final grade is the sum of the following grades: 30% of the average of the grades of the weekly assignments 30% of the average of the grades of the weekly written tests

Activity	*Semester workload*
Lectures	52
Assignments/Projects	30
Directed learning activity (office hours)	26
Non-directed learning activity	66
Course total	**174**

Specifically defined evaluation criteria are given, and if and where they are accessible to students.	40% of the grade of the final project

(5) ATTACHED BIBLIOGRAPHY

- *Lecture notes*
- *"Optics", E. Hecht, Addison-Wesley, (2001).*
- *"Principles of Optics", M. Born, E. Wolf.*
- *"Introduction to Modern Optics", G.R. Fowles, Dover, (1989).*
- *"Introduction to Fourier Optics", J. W. Goodman, McGraw-Hill, (1996).*

Bibliography: exercises with solutions

- *"Solved exercises in Optics", D. Papazoglou, UoC, (2023).*

THIRD AND FOURTH SEMESTER – DIPLOMA THESIS

Overview

The Master Thesis is conducted during the 2nd year (3rd and 4th semester). The title of the thesis, the supervisor and the members of the examination committee, are determined by the General Assembly of the Department upon request of the students to the Steering Committee of the Postgraduate Program.

The Postgraduate Diploma Thesis concerns original experimental, or theoretical, or computational, research work in the scientific area of the Postgraduate Program. It corresponds to a total educational load of 60 ECTS and is conducted in 4 stages (which may partially overlap in time) as described in the table below:

CODE	Course Title (English-Greek)	ECTS
MEMY-601	Methods of Scientific Bibliographic Search	10
MEMY-602	Research Laboratory 1	10
MEMY-603	Research Laboratory 2	10
MEMY-604	Preparation of the Postgraduate Thesis	30

In the first stage (MEMY-601), a literature review of the scientific area to which the thesis refers is carried out in order to form a complete scientific background and the plan for the elaboration of the Master's Thesis is finalized. The second and third stages (MEMY-602, MEMY-603) concern the conduct of the research work. This may include, for example, the implementation of experimental devices, the conduct of experiments, the development of algorithms, the collection and processing of data and measurements. The 4th stage (MEMY-604) includes the completion of the analysis of the results, the conduct of the final conclusions, and concludes with the writing of the Master's Thesis and its public support before the Examination Committee.

Below are given in detail the outlines that refer to each of the 4 stages of conducting the Master's Thesis.

MEMY-601. Methods of Scientific Bibliographic Search

GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	MATERIALS SCIENCE AND TECHNOLOGY		
LEVEL OF STUDY	POSTGRADUATE		
COURSE CODE	**MEMY 601**	**SEMESTER OF STUDY**	**C**
COURSE TITLE	**Methods of Scientific Bibliographic Search** (*Scientific Bibliographic Search Methods)*		
INDEPENDENT TEACHING ACTIVITIES		**TEACHING WEEKS**	**CREDITS**
			10
COURSE TYPE	Specific background, specialization, general knowledge, skills development		
PREREQUISITE COURSES:	-		
LANGUAGE OF INSTRUCTION AND EXAMINATIONS:	English		
THE COURSE IS OFFERED TO ERASMUS STUDENTS	NO		
COURSE WEBSITE (URL)	https://mscs.uoc.gr/dmst/?courses=methods-for-scientific-literature-search		

(2) LEARNING OUTCOMES

Learning Outcomes

Upon successful completion of the course, students will:

- *They have developed the necessary skills and competencies to conduct research: understanding and presenting scientific articles, writing a literature review, cultivating scientific judgment, formulating research hypotheses and checking their correctness.*
- *They have built a solid foundation of prior knowledge of the field*
- *They are able to identify recent developments in the field and evaluate the relevance of a publication and the reliability of the results presented*
- *Understand the state of science and open questions in the field*

General Competencies

- *Troubleshoot complex problems*
- *Development of scientific thinking*
- *Use of the university library and multiple bibliographic sources*
- *Management of time and deadlines*
- *Development of the ability to summarize concepts*
- *Teamwork*

(3) COURSE CONTENT

Dependent on the subject of the postgraduate thesis

(4) TEACHING AND LEARNING METHODS - ASSESSMENT

DELIVERY METHOD	Face to face
USE OF INFORMATION AND COMMUNICATION TECHNOLOGIES	All available and appropriate ways
TEACHING ORGANIZATION	
STUDENT EVALUATION	Assessment language: English Presentation of the Literature Review and Master's Plan

Activity	***Semester Workload (hours)***
Literature study & analysis	110
Directed learning activity	40
Non-directed learning activity	100
Total Course	**250**

(5) RECOMMENDED-BIBLIOGRAPHY

Dependent on the postgraduate thesis

MEMY-602. Research Laboratory 1

GENERAL

SCHOOL	SCIENCES AND ENGINEERING			
ACADEMIC UNIT	MATERIALS SCIENCE AND TECHNOLOGY			
LEVEL OF STUDY	POSTGRADUATE			
COURSE CODE	**MEMY 602**	**SEMESTER OF STUDY**		**C**
COURSE TITLE	**Research Laboratory 1**			
INDEPENDENT TEACHING ACTIVITIES			**TEACHING WEEKS**	**CREDITS**
				10
COURSE TYPE	Specific background, specialization, general knowledge, skills development			
PREREQUISITE COURSES:	-			
LANGUAGE OF INSTRUCTION AND EXAMINATIONS:	English			
THE COURSE IS OFFERED TO ERASMUS STUDENTS	NO			
COURSE WEBSITE (URL)	https://mscs.uoc.gr/dmst/?courses=methods-for-scientific-literature-search			

(2) LEARNING OUTCOMES

Learning Outcomes
Upon successful completion of the course, students will: • *They have built a solid foundation of prior knowledge of the field* • *They have learned how to conduct research, related ethical issues, how to make presentations and will have gained insights into the relevant research direction and cutting-edge research* • *They have learned to apply their knowledge in solving practical problems* • *They have cultivated their ability to work in teams*
General Competencies
• *Troubleshoot complex problems* • *Development of scientific thinking* • *Adaptation to new situations, exposure to international environment* • *Autonomous work* • *Management of time and deadlines* • *Development of the ability to summarize concepts* • *Teamwork*

(3) COURSE CONTENT

Dependent on the postgraduate thesis

(4) TEACHING AND LEARNING METHODS - ASSESSMENT

<table>
<tr><td>DELIVERY METHOD</td><td>Face to face</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATION TECHNOLOGIES</td><td>All available and appropriate ways</td></tr>
<tr><td>TEACHING ORGANIZATION</td><td>
<table>
<tr><th>Activity</th><th>Semester Workload (hours)</th></tr>
<tr><td>Research work such as implementation of experimental devices/ conduct of experiments/ development of algorithms/ collection and processing of data and measurements</td><td>160</td></tr>
<tr><td>Directed learning activity</td><td>40</td></tr>
<tr><td>Non-directed learning activity</td><td>50</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Total Course</td><td>250</td></tr>
</table>
</td></tr>
<tr><td>STUDENT EVALUATION</td><td>Assessment language: English

Presentation of Master's Thesis progress</td></tr>
</table>

(5) RECOMMENDED-BIBLIOGRAPHY

- Dependent on the subject of the postgraduate thesis

MEMY-603. Research Laboratory 2

GENERAL

SCHOOL	SCIENCES AND ENGINEERING			
ACADEMIC UNIT	MATERIALS SCIENCE AND TECHNOLOGY			
LEVEL OF STUDY	POSTGRADUATE			
COURSE CODE	**MEMY 603**		**SEMESTER OF STUDY**	**C**
COURSE TITLE	**Research Laboratory 2**			
INDEPENDENT TEACHING ACTIVITIES		**TEACHING WEEKS**	**CREDITS**	
			10	
COURSE TYPE	Specific background, specialization, general knowledge, skills development			
PREREQUISITE COURSES:	-			
LANGUAGE OF INSTRUCTION AND EXAMINATIONS:	English			
THE COURSE IS OFFERED TO ERASMUS STUDENTS	NO			
COURSE WEBSITE (URL)	https://mscs.uoc.gr/dmst/?courses=research-laboratory-2			

(2) LEARNING OUTCOMES

Learning Outcomes
Upon successful completion of the course, students will: • *They have built a solid foundation of prior knowledge of the field.* • *They have learned how to conduct research, related ethical issues, how to make presentations and will have gained insights into the relevant research direction and cutting-edge research.* • *They have learned to apply their knowledge in solving practical problems.* • *They have cultivated their ability to work in teams*
General Competencies
• *Troubleshoot complex problems* • *Development of scientific thinking* • *Adaptation to new situations, exposure to international environment* • *Autonomous work* • *Management of time and deadlines* • *Development of the ability to summarize concepts.* • *Teamwork*

(3) COURSE CONTENT

Dependent on the postgraduate thesis

(4) TEACHING AND LEARNING METHODS - ASSESSMENT

DELIVERY METHOD	Face to face
USE OF INFORMATION AND COMMUNICATION TECHNOLOGIES	All available and appropriate ways
TEACHING ORGANIZATION	

Activity	***Semester Workload (hours)***
Research work such as implementation of experimental devices/ conduct of experiments/ development of algorithms/ collection and processing of data and measurements	160
Directed learning activity	40
Non-directed learning activity	50
Total Course	**250**

STUDENT EVALUATION	Assessment language: English Presentation of Master's Thesis progress

(5) RECOMMENDED-BIBLIOGRAPHY

- Dependent on the subject of the postgraduate thesis

MEMY-604. Preparation of the Postgraduate Thesis

GENERAL

SCHOOL	SCIENCES AND ENGINEERING			
ACADEMIC UNIT	MATERIALS SCIENCE AND TECHNOLOGY			
LEVEL OF STUDY	POSTGRADUATE			
COURSE CODE	**MEMY 604**	**SEMESTER OF STUDY**	**D**	
COURSE TITLE	**Preparation of the Postgraduate Thesis**			
INDEPENDENT TEACHING ACTIVITIES		**TEACHING WEEKS**	**CREDITS**	
			30	
COURSE TYPE	Specific background, specialization, general knowledge, skills development			
PREREQUISITE COURSES:	-			
LANGUAGE OF INSTRUCTION AND EXAMINATIONS:	English			
THE COURSE IS OFFERED TO ERASMUS STUDENTS	NO			
COURSE WEBSITE (URL)	https://mscs.uoc.gr/dmst/?courses=masters-thesis			

(2) LEARNING OUTCOMES

Learning Outcomes

Upon successful completion of the course, students will:

- *They have built a solid foundation of prior knowledge of the field*
- *They have acquired specialization (theoretical knowledge and specialized skills) in the areas of specialization of the postgraduate thesis.*
- *They have learned how to conduct research, related ethical issues, how to make presentations and will have gained insights into the relevant research direction and cutting-edge research*
- *They have developed the necessary skills and competencies to conduct research: understanding and presenting scientific articles, writing a literature review, cultivating scientific judgment, formulating research hypotheses and checking their correctness.*
- *They have cultivated their ability to work in teams through their participation in collaborative research and development projects with industry or academia.*
- *They have learned to apply their knowledge in solving practical problems*
- *Have deepened the knowledge they have acquired in their undergraduate studies and develop their transferability to specific fields*

General Competencies

- *Troubleshoot complex problems*
- *Development of scientific thinking*
- *Decision-making*
- *Adaptation to new situations, exposure to international environment*
- *Autonomous work*

- *Management of time and deadlines*
- *Development of the ability to summarize concepts*
- *Teamwork*

(3) COURSE CONTENT

Dependent on the subject of the postgraduate thesis

(4) TEACHING AND LEARNING METHODS - ASSESSMENT

DELIVERY METHOD	Face to face
USE OF INFORMATION AND COMMUNICATION TECHNOLOGIES	All available and appropriate ways
TEACHING ORGANIZATION	see table below

Activity	*Semester Workload (hours)*
Completion of the analysis of the results/ carrying out the final conclusions, conducting experiments	70
Guided Study	30
Postgraduate Thesis Writing	150
Total Course	**250**

STUDENT EVALUATION

Assessment language: English

The student makes a public presentation before the examination committee. The postgraduate thesis is examined by the examination committee in accordance with the applicable provisions and includes an oral presentation of the dissertation before an audience at a date and time set by the examination committee.

After the completion of the public presentation of the dissertation by the postgraduate student, the committee grades it on a scale of 0-10 and informs the Department Secretariat with a written report.

If the dissertation is considered by the committee as unsatisfactory and scored below base 5, then the committee may ask the graduate student to improve it, modify some parts of it, or radically reform it. The committee sets a specific time frame within which the dissertation should be resubmitted and modified according to its suggestions.

The Thesis text must meet the specifications and structure of a scientific paper, i.e. include a description of the topic of the work, a description of the findings - results of the work, the methodology, assumptions, bibliography and any other necessary supporting or explanatory elements (necessary shapes, diagrams, photographs, images, etc.). It is written in English and is accompanied by a short summary of up to approximately 300 words in Greek and English. In the first pages of the Thesis, should include a statement of the postgraduate student that this work is not plagiarized either in whole or in individual parts of it

(5) RECOMMENDED-BIBLIOGRAPHY

- Dependent on the postgraduate thesis