ΠΑΝΕΠΙΣΤΗΜΙΟ ΚΡΗΤΗΣ

ΤΜΗΜΑ ΕΠΙΣΤΗΜΗΣ ΚΑΙ ΜΗΧΑΝΙΚΗΣ ΥΛΙΚΩΝ

Περιγράμματα Μαθημάτων

ΤΟΥ ΝΕΟΥ ΠΡΟΓΡΑΜΜΑΤΟΣ ΜΕΤΑΠΤΥΧΙΑΚΩΝ ΣΠΟΥΔΩΝ

«Επιστήμη και Μηχανική στη Χαλαρή Ύλη»

“Soft Matter Science and Engineering”

ΙΑΝΟΥΑΡΙΟΣ 2024

Table of contents

1st YEAR, 1st SEMESTER

SM1 Applied mathematics and methods of analysis

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIAL SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	SM1	**SEMESTER**	1
COURSE TITLE	Applied mathematics and methods of analysis		
INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*		**WEEKLY TEACHING HOURS**	**CREDITS**
		3	5
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).			
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Special background		
PREREQUISITE COURSES:			
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	English		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes		
COURSE WEBSITE (URL)	https://www.materials.uoc.gr		

(2) LEARNING OUTCOMES

Learning outcomes

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

Consult Appendix A

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

Upon completion of the course, the graduate students are expected to:

1. be familiar with basic methods of mathematical analysis (for example statistical analysis of data, defining initial/boundary conditions and solving simple differential equations).

2. use their knowledge for simplifying equations developed in modeling and solve them.

3. appreciate the limiting cases of complex differential equations (for example, steady state).

4. properly use software packages to solve equations.

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…*
	…….

1. Quantitative analysis using appropriate tools (modeling, software packages).

2. Develop critical and creative thinking

3. Work in multidisciplinary environment to tackle complex problems. Combine information from different areas and extract the punchline in a given problem.

(3) SYLLABUS

1. Review of statistics. Averages, standard deviation, and moments. Error analysis.
2. Vector and tensor calculus.
3. Dimensional analysis
4. Ordinary differential equations: theory and applications
5. Partial differential equations. Separation of variables.
6. Laplace and Fourier transformations.
7. Special topics of differential equations in science & engineering.

(4) TEACHING and LEARNING METHODS - EVALUATION

<table>
<tr><td>DELIVERY
Face-to-face, Distance learning, etc.</td><td>Face-to-face</td></tr>
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Use of ICT in teaching, laboratory education, communication with students</td><td>Use of educational videos, use of open-source software with example data, online mathematical tools for solving/plotting solutions. Use of e-class for distribution of lecture notes, videos, links, questionnaires, suggested and solved exercises.</td></tr>
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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.

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Description of the evaluation procedure

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

Specifically-defined evaluation criteria are given, and if and where they are accessible to students.</td><td>Formative (Assessment of progress without grade consequence)
- Weekly suggested exercises
- Oral participation in solving problems during lectures

Conclusive (Evaluation with grading consistency)
- One midterm
- Final written exam

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

(5) ATTACHED BIBLIOGRAPHY

- *Suggested bibliography:*

J. D. Logan, Applied Mathematics 3rd Edition, Wiley, 2006
K. F. Riley, M. P. Hobson, S. J. Bence, Mathematical Methods for Physics and Engineering: A Comprehensive Guide 3rd Edition, Cambridge, 2006
L. A. Glasgow, Applied Mathematics for Science and Engineering 1st Edition, Wiley, 2014
L. A. Pipes, L. R. Harvill, Applied Mathematics for engineers and physicists, 3rd Ed., Dover, 2014

SM2 Thermodynamics and transport processes for soft materials

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIAL SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	SM2	**SEMESTER**	1
COURSE TITLE	Thermodynamics and transport processes for soft 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**
	3	5
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COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Special background
PREREQUISITE COURSES:	
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	English
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes
COURSE WEBSITE (URL)	https://www.materials.uoc.gr

(2) LEARNING OUTCOMES

Learning outcomes

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

Consult Appendix A

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

Upon completion of the course, the graduate students are expected to:

1. be familiar with laws of thermodynamics and their importance in understanding equilibria in soft materials and phase transitions.

2. use their knowledge for determining phase diagrams and understanding stability of phases

3. understand how phase transitions are affected by external conditions (temperature, pressure, additive)

4. be familiar with Boltzmann's entropy and, in a broader sense, the importance of entropy for soft materials

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*
	Respect for the natural environment

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

1. Quantitative analysis of thermodynamic processes and transitions.

2. Develop critical and creative thinking

3. Combine information (thermodynamic variables, interactions, degrees of freedom) to tackle problems.

4. Individual term paper to test the above skills.

(3) SYLLABUS

1. The laws of thermodynamics. Applications to heat engines.

2. General equation of thermodynamics. Free energy and chemical potential.

3. Simple phase diagrams and stability.

4. Colligative properties. Osmosis.

5. Chemical reaction thermodynamics.

6. Elements of statistical thermodynamics. Boltzmann's entropy and applications to soft materials.

7. Elements of non-equilibrium thermodynamics.

(4) TEACHING and LEARNING METHODS - EVALUATION

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<tr><th>Activity</th><th>Semester workload</th></tr>
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<tr><td>Exercise section</td><td>10</td></tr>
<tr><td>Office hours</td><td>26</td></tr>
<tr><td>Optional Project</td><td>(15)</td></tr>
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Description of the evaluation procedure

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

Specifically-defined evaluation criteria are given, and if and where they are accessible to students.</td><td>Formative (Assessment of progress without grade consequence)
- Weekly suggested exercises
- Oral participation in solving problems during lectures

Conclusive (Evaluation with grading consistency)
- One midterm
- Term paper (optional)
- Final written exam

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

- *Suggested bibliography:*

S. I. Sandler, Chemical, Biochemical and Engineering Thermodynamics, 5th Ed., Wiley, 2017

R. Hentschke, Thermodynamics for physicists, chemists and material scientists, 2nd Ed., Springer 2022

A.Z. Panagiotopoulos, Essential Thermodynamics, Drios Press, 2011.

SM3 Synthetic methodologies and characterization of Soft Matter

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIAL SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	SM3	**SEMESTER**	1
COURSE TITLE	Synthetic methodologies and characterization of Soft Matter		

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

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

(2) LEARNING OUTCOMES

Learning outcomes

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

Consult Appendix A

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

Upon completion of the course, the graduate students are expected to:

1. be familiar with the principles of synthesis and molecular/macromolecular characterization of soft materials.
2. understand the advantages and limitations of the polymer and polymer colloid synthesis techniques.
3. be able to select the appropriate method for the targeted polymer synthesis

The student's familiarization with the field is based on the learning of the basic principles in combination with the presentation of selected examples from the recent scientific 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*
	Respect for the natural environment

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

1. Development of critical and interdisciplinary thinking
2. Search for, analysis and synthesis of data and information, with the use of the necessary technology
3. Production of free, creative and inductive thinking linking the basic principles governing the structure and dynamics of soft materials with their applications.
4. Individual project or term paper to test the above skills.

(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. Synthesis

   6.1 Polymerization methods:
   - Step-growth-Polycondensation
   - Addition, Free-radical polymerization
   - "Living"/controlled polymerizations
     - anionic - cationic
     - ATRP
     - RAFT
   - Ring opening polymerization

   6.2 Polymerization techniques
   - Emulsion – Dispersion polymerization (Polymer colloid synthesis)
7. Molecular/macromolecular characterization
   - Methods to determine the polymer molecular weight and molecular weight distribution
   - Determination of the chemical polymer structure and composition by ^{1}H-NMR, FTIR, UV/Vis spectroscopies

(4) TEACHING and LEARNING METHODS - EVALUATION

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Description of the evaluation procedure

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

Specifically-defined evaluation criteria are given, and if and where they are accessible to students.</td><td>Formative (Assessment of progress without grade consequence)
- Weekly suggested exercises
- Oral participation in solving problems during lectures

Conclusive (Evaluation with grading consistency)
- One midterm
- Project or term paper (optional)
- Final written exam

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

- *Suggested bibliography:*

Lodge T.P., Hiemenz, P.C., Polymer Chemistry, 3rd Edition, CRC Press, 2020.

Young, R.J., Lovell, P.A., Introduction to Polymers, 3rd Edition, CRC Press, 2011.

Allcock, H.R.; Lampe, F.W. Contemporary Polymer Chemistry, 3rd Edition, Prentice Hall, 2003.

SM4 Soft matter characterization

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIAL SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	SM4	**SEMESTER**	1
COURSE TITLE	Soft matter characterization		

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

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

(2) LEARNING OUTCOMES

Learning outcomes

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

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

Upon completion of the course, the graduate students are expected to:

1. be familiar with the different methods/techniques to characterize materials.
2. use their knowledge for deciding the main material features/properties that should be assessed
3. understand the importance/consequence of ill-characterized materials in assessing properties/performance
4. understand the importance of material characterization in designing new materials/formulations

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

Working independently	*issues*
Team work	*Criticism and self-criticism*
Working in an international environment	*Production of free, creative and inductive thinking*
Working in an interdisciplinary environment	*……*
Production of new research ideas	*Others…*
	…….

1. Basic characterization techniques

2. Develop critical and creative thinking

3. Critically combine information from different characterization methodologies.

4. Individual project or term paper to test the above skills.

(3) SYLLABUS

1. Molecular parameters for material characterization.

2. Light scattering

3. X-ray and neutron scattering

4. Optical microscopy

5. Electron microscopy

6. Vibrational spectroscopy (IR, Raman, NMR)

7. AFM and surface techniques

8. Thermal analysis

9. Dynamic mechanical analysis

10. In-situ experimentation (rheo-physics)

(4) TEACHING and LEARNING METHODS - EVALUATION

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<tr><td>Exercise section</td><td>14</td></tr>
<tr><td>Office hours</td><td>26</td></tr>
<tr><td>Optional Project</td><td>(15)</td></tr>
<tr><td>Independent study</td><td>60</td></tr>
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Description of the evaluation procedure

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

Specifically-defined evaluation criteria are given, and if and where they are accessible to students.</td><td>Formative (Assessment of progress without grade consequence)
- Weekly suggested exercises
- Oral participation in solving problems during lectures

Conclusive (Evaluation with grading consistency)
- One midterm
- Project or term paper (optional)
- Final written exam

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

(5) ATTACHED BIBLIOGRAPHY

- *Suggested bibliography:*

L. Yang, Materials Characterization, 2nd Ed., Wiley, 2013.

R. Borsali, R. Pecora (eds.), Soft Matter Characterization, Springer, 2008.

SM5 Soft matter seminar

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIAL SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	SM5	**SEMESTER**	1
COURSE TITLE	Soft matter seminar		

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

(2) LEARNING OUTCOMES

Learning outcomes

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- *Guidelines for writing Learning Outcomes*

Upon completion of the course, the graduate students are expected to:

1. have a broad overview of current trends and challenges in soft materials research.

2. understand the importance of soft materials in contemporary societal challenges (environment, energy, circular economy, biomedicine)

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 *Working in an interdisciplinary environment* *Production of new research ideas*	*Production of free, creative and inductive thinking* *……* *Others…* *…….*

1. obtain a grasp of critical soft material properties for different applications

2. develop critical and creative thinking

3. Individual term paper to test the above skills.

(3) SYLLABUS

1. Weakly seminars by experts in different types/applications of soft materials

2. Presentation skills

3. Reporting skills

4. Criteria for assessing presentations

(4) TEACHING and LEARNING METHODS - EVALUATION

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Specifically-defined evaluation criteria are given, and if and where they are accessible to students.</td><td>Formative (Assessment of progress without grade consequence)
- Weekly suggested exercises
- Oral participation in solving problems during lectures

Conclusive (Evaluation with grading consistency)
- Term paper
- Final oral exam

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

(5) ATTACHED BIBLIOGRAPHY

- *Suggested bibliography:*

W. van Saarloos, V. Vitelli, Z. Zeravcic, Soft Matter: concepts, phenomena and applications, Princeton, 2024.

I.W. Hamley, Introduction to soft matter, revised ed., Wiley, 2007.

T.C. B. McLeish, Soft matter: a very short introduction, Oxford, 2020.

SM11 Advanced synthesis of soft materials

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIAL SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	SM11	**SEMESTER**	1
COURSE TITLE	Advanced synthesis of soft 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**
	3	5
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

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

(2) LEARNING OUTCOMES

Learning outcomes

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

Consult Appendix A

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

Upon completion of the course, the graduate students are expected to:

1. be familiar with the kinetics of the polymerization reactions and their effect on the macromolecular characteristics.
2. consolidate the basic principles of the polymerization kinetics and be able to predict the macromolecular characteristics.
3. use their knowledge for deciding the polymer synthesis method to prepare a polymer with certain characteristics

The student's familiarization with the field is based on the learning of the basic principles in combination with the presentation of selected examples from the recent scientific 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…*
	…….

1. Development of interdisciplinary and critical thinking
2. Search for, analysis and synthesis of data and information, with the use of the necessary technologies
3. Working independently
4. Team work
5. Project planning and management
6. Production of free, creative and inductive thinking

(3) SYLLABUS

1. Step-growth Polymerization
   - Type of step reactions
   - Molecular weight and polydispersity
   - Kinetics of condensation polymerization
   - Examples
2. Free-radical Polymerization
   - Mechanism of free-radical polymerization
   - Molecular weight and polydispersity
   - Kinetics of free-radical polymerization
   - Examples
   - Copolymerization and kinetics
3. Anionic Polymerization
   - Mechanism of anionic polymerization
   - Molecular weight and polydispersity
   - Kinetics of anionic polymerization
   - Macromolecular architectures accessible via anionic polymerization
4. Group Transfer Polymerization
5. Coordination Polymerization
6. Cationic Polymerization
   - Mechanism of cationic polymerization
   - Molecular weight and polydispersity
   - Kinetics of cationic polymerization
7. Controlled Radical Polymerization
   - Mechanisms of NMP, ATRP and RAFT
   - Molecular weight and polydispersity
   - Kinetics of controlled radical polymerization
8. Ring Opening Polymerization
   - Mechanism of ring opening polymerization
   - Monomers and related polymers
   - Kinetics of ring opening polymerization
9. Post-polymerization modification reactions
10. Synthesis of polymer gels and hydrogels
11. Synthesis of grafted polymer chains on flat and curved surfaces

(4) TEACHING and LEARNING METHODS - EVALUATION

<table>
<tr><td>DELIVERY
Face-to-face, Distance learning, etc.</td><td>Face-to-face</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
Use of ICT in teaching, laboratory education, communication with students</td><td>Use of educational videos, use of open-source software with example data, online mathematical tools for solving/plotting solutions. Use of e-class for distribution of lecture notes, videos, links, questionnaires, suggested and solved exercises.</td></tr>
<tr><td>TEACHING METHODS
The manner and methods of teaching are described in detail.
Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.

The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS</td><td>
<table>
<tr><th>Activity</th><th>Semester workload</th></tr>
<tr><td>Lectures</td><td>29</td></tr>
<tr><td>Exercise section</td><td>10</td></tr>
<tr><td>Office hours</td><td>26</td></tr>
<tr><td>Optional Project</td><td>(15)</td></tr>
<tr><td>Independent study</td><td>60</td></tr>
<tr><td>Course total</td><td>125 (140)</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>Formative (Assessment of progress without grade consequence)
- Weekly suggested exercises
- Oral participation in solving problems during lectures

Conclusive (Evaluation with grading consistency)
- One midterm
- Project or term paper (optional)
- Final written exam

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

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- Lodge T.P., Hiemenz, P.C., Polymer Chemistry, 3rd Edition, CRC Press, 2020.
- Young, R.J., Lovell, P.A., Introduction to Polymers, 3rd Edition, CRC Press, 2011.
- Allcock, H.R.; Lampe, F.W. Contemporary Polymer Chemistry, 3rd Edition, Prentice Hall, 2003.
- Matyjaszewski, K.; Müller, A. H. E. Controlled and Living Polymerizations: From Mechanisms to Applications, John Wiley & Sons, 2009.
- Matyjaszewski, K. Controlled/living Radical Polymerization: Progress in ATRP, American Chemical Society, 2009.

SM13 Soft materials for energy and the environment

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIAL SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	SM13	**SEMESTER**	1
COURSE TITLE	Soft materials for energy and the 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**
		3	5
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).			
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Special background		
PREREQUISITE COURSES:			
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	English		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes		
COURSE WEBSITE (URL)	https://www.materials.uoc.gr		

(2) LEARNING OUTCOMES

Learning outcomes

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

Consult Appendix A

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

Upon completion of the course, the graduate students are expected to:

1. understand the basic properties of soft materials necessary for applications related to energy and environment

2. use their knowledge to develop criteria for developing material formulations with desired properties in targeted applications

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 *Working in an interdisciplinary environment* *Production of new research ideas*	*Production of free, creative and inductive thinking* *……* *Others…* *…….*

1. Main features of soft materials for energy and environmental applications

2. Combine knowledge from properties of different classes (polymers, colloids) to develop soft material composites with desired function and develop design criteria

3. Individual term paper to test the above skills.

(3) SYLLABUS

1. Main properties needed for applications in energy and environment: friction, mechanical strength, electric conductivity, miscibility, biodegradability.

2. Polymeric composites and gels for batteries and supercapacitors

3. Polymeric materials for renewable energy production

4. Microporous polymers for gas separation/purification

5. Recycling of thermoplastics

6. Recycling of elastomers

7. Microplastics management

8. Biodegradable polymers

9. Green/bio-based soft matter

10. Water purification and soil remediation

11. Turbulent drag reduction

(4) TEACHING and LEARNING METHODS - EVALUATION

<table>
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Face-to-face, Distance learning, etc.</td><td>Face-to-face</td></tr>
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- Weekly suggested exercises
- Oral participation in solving problems during lectures

Conclusive (Evaluation with grading consistency)
- One midterm
- term paper (optional)
- Final written exam

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

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

Class notes and research papers/reviews for each topic covered

SM16 Advanced topics II

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIAL SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	SM16	**SEMESTER**	1
COURSE TITLE	Advanced topics II (examples: new modeling/simulation methods, AI)		

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

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

(2) LEARNING OUTCOMES

Learning outcomes

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

Consult Appendix A

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

Upon completion of the course, the graduate students are expected to:

1. be familiar with current trends in modeling and simulations

2. understand how to select a modeling or simulation approach to investigate the properties of a specific material or class of materials

3. understand the usefulness and challenges associated with the use of AI in materials science

General Competences

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

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

Production of new research ideas	*Others…* *…….*

1. Main features (advantages/disadvantages) of different modeling/simulation approaches

2. Apply AI in soft materials

3. Individual term paper to test the above skills

(3) SYLLABUS

1. Advanced modeling of polymers: dynamics in covalent and living chains

2. Advanced modeling of colloids: hydrodynamic interactions, friction, metastable systems

3. Advanced topics in simulations of soft materials: Gibbs ensemble simulations, accelerated simulations, atomistic molecular dynamics, hydrodynamic effects

4. Analysis of interfacial phenomena with soft materials

5. AI in soft materials science

6. Special topics (depending on students' interests)

TEACHING and LEARNING METHODS - EVALUATION

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

Specifically-defined evaluation criteria are given, and if and where they are accessible to students.</td><td>Formative (Assessment of progress without grade consequence)
- Weekly suggested exercises
- Oral participation in solving problems during lectures

Conclusive (Evaluation with grading consistency)
- One midterm
- term paper (optional)
- Final written exam

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

(4) ATTACHED BIBLIOGRAPHY

- *Suggested bibliography:*

Class notes and research papers/reviews for each topic covered

SM17 Advanced topics III

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIAL SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	SM17	**SEMESTER**	1
COURSE TITLE	Advanced topics III (examples: active matter, vitrimers, cell mechanics, new instrumentation)		

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

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

(2) LEARNING OUTCOMES

Learning outcomes

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

Consult Appendix A

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- *Guidelines for writing Learning Outcomes*

Upon completion of the course, the graduate students are expected to:

1. understand the basic features associated with the topics covered (e.g., vitrimers, active matter)

2. use their knowledge to discern materials (e.g., vitrimers from elastomers or active from passive materials) and consider applications related to the topics covered

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 *Working in an interdisciplinary environment* *Production of new research ideas*	*Production of free, creative and inductive thinking* *……* *Others…* *…….*

1. Main features/properties of active materials, vitrimers, cell

2. Combine knowledge from properties of different classes (polymers, colloids) to understand and tailor the properties of active materials, vitrimers and control the mechanics of cells.

3. Individual term paper to test the above skills.

(3) SYLLABUS

1. Active matter: synthetic and living

2. Transport properties of active materials

3. Associating polymers and vitrimers: comparison of properties and perspectives

4. Use of vitrimers as rheology modifiers

5. Mechanical and rheological properties of the cell

6. Instrumentation to probe the dynamics of living and biological matter

7. Special topics (depending on students' interests)

TEACHING and LEARNING METHODS - EVALUATION

<table>
<tr><td>DELIVERY
Face-to-face, Distance learning, etc.</td><td>Face-to-face</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
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<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

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- Weekly suggested exercises
- Oral participation in solving problems during lectures

Conclusive (Evaluation with grading consistency)
- One midterm
- term paper (optional)
- Final written exam

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

(4) ATTACHED BIBLIOGRAPHY

- *Suggested bibliography:*

Class notes and research papers/reviews for each topic covered

1st YEAR, 2nd SEMESTER

SM6 Introduction to biophysics and biopolymers

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIAL SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	SM6	**SEMESTER**	2
COURSE TITLE	Introduction to biophysics and biopolymers		
INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*		**WEEKLY TEACHING HOURS**	**CREDITS**
		3	5
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).			
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Special background		
PREREQUISITE COURSES:			
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	English		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes		
COURSE WEBSITE (URL)	https://www.materials.uoc.gr		

(2) LEARNING OUTCOMES

Learning outcomes

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

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- *Guidelines for writing Learning Outcomes*

Upon completion of the course, the graduate students are expected to:

1. distinguish biomaterials from synthetic materials

2. use their knowledge to understand the main features of biological materials in different functions (regenerative medicine, drug delivery)

3. understand the role of interactions and molecular features of specific biomaterials in different applications

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*
	Respect for difference and multiculturalism

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

1. Basic types of biomaterials and biological interactions

2. Develop critical and creative thinking

3. Critical assessment of biological interactions.

4. Individual term paper to test the above skills.

(3) SYLLABUS

1. Energies and interactions in biological materials

2. Biological macromolecules *vs* synthetic macromolecules

3. DNA, RNA and protein folding

4. Polysaccharides and molecular recognition

5. Molecular biology of the cell, cell-biomaterial interactions

6. Membranes

7. Movement of organisms

8. Drug delivery systems

9. Tissue engineering

10. Clinical applications

11. Nerve signaling, movement of organisms

(4) TEACHING and LEARNING METHODS - EVALUATION

<table>
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Description of the evaluation procedure

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- One midterm
- Term paper (optional)
- Final written exam

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

(5) ATTACHED BIBLIOGRAPHY

- *Suggested bibliography:*

H. Schiessel, Biophysics for beginners, 2nd ed., Jenny Stanford Publishing, 2021.

C. M. Agrawal, J. L. Ong, M. R. Appleford, G. Mani, Introduction to biomaterials, Cambridge 2014.
R. Cotterill, Biophysics: an introduction, Wiley, 2002.

SM7 Interfacial phenomena in soft matter

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIAL SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	SM7	**SEMESTER**	2
COURSE TITLE	Interfacial phenomena in soft matter		

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

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

(2) LEARNING OUTCOMES

Learning outcomes

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

Consult Appendix A

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

Upon completion of the course, the graduate students are expected to:

1. understand the importance of interfaces in the properties of soft materials

2. use their knowledge to develop criteria for tailoring/improving material properties using interfacial characteristics (miscibility, interactions, laden interfaces, dynamics)

3. acquire skills to further explore interfacial phenomena and the structure and dynamics of soft materials near interfaces

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*
	Respect for the natural environment

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

1. Basic properties of interfaces

2. Develop critical and creative thinking

3. Use of interfacial phenomena to tailor material properties

4. Individual term paper to test the above skills.

(3) SYLLABUS

1. Liquid and solid surfaces

2. Thermodynamics of interfaces

3. Surface forces, charged interfaces

4. Contact angle phenomena and wetting

5. Adsorption

6. Friction, lubrication, wear

7. Surface modification

8. Surfactants, micelles, emulsions, foams, colloidal stability, interfacial adhesion

9. Thin films

10. Surface modification

(4) TEACHING and LEARNING METHODS - EVALUATION

<table>
<tr><td>DELIVERY
Face-to-face, Distance learning, etc.</td><td>Face-to-face</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
Use of ICT in teaching, laboratory education, communication with students</td><td>Use of educational videos, use of open-source software with example data, online mathematical tools for solving/plotting solutions. Use of e-class for distribution of lecture notes, videos, links, questionnaires, suggested and solved exercises.</td></tr>
<tr><td>TEACHING METHODS
The manner and methods of teaching are described in detail.
Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.

The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS</td><td>
<table>
<tr><th>Activity</th><th>Semester workload</th></tr>
<tr><td>Lectures</td><td>39</td></tr>
<tr><td>Exercise section</td><td></td></tr>
<tr><td>Office hours</td><td>26</td></tr>
<tr><td>Optional Project</td><td>(15)</td></tr>
<tr><td>Independent study</td><td>60</td></tr>
<tr><td>Course total</td><td>125 (140)</td></tr>
</table>
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<tr><td>STUDENT PERFORMANCE EVALUATION
Description of the evaluation procedure

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

Specifically-defined evaluation criteria are given, and if and where they are accessible to students.</td><td>Formative (Assessment of progress without grade consequence)
- Weekly suggested exercises
- Oral participation in solving problems during lectures

Conclusive (Evaluation with grading consistency)
- One midterm
- Term paper (optional)
- Final written exam

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

(5) ATTACHED BIBLIOGRAPHY

- *Suggested bibliography:*

P. Lang, Y. Liu (eds.), Soft matter at aqueous interfaces, Springer, 2016.

H-J. Butt, K. Graf, M. Kappl, Physics and Chemistry of Interfaces, 3rd. ed., Wiley, 2013.

SM8 Polymer and colloid physics

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIAL SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	SM8	**SEMESTER**	2
COURSE TITLE	Polymer and colloid physics		

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

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

(2) LEARNING OUTCOMES

Learning outcomes

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

Consult Appendix A

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

Upon completion of the course, the graduate students are expected to:

1. understand the essential differences between polymers and colloids and the role of these two classes of materials as pillars of soft matter research and engineering

2. use their knowledge to develop criteria for manipulating the properties of composite materials (for example, reinforcement, depletion gelation)

3. know the basic ingredients needed to design or modify materials with desired properties for targeted applications

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

Respect for difference and multiculturalism

Adapting to new situations *Decision-making* *Working independently* *Team work* *Working in an international environment* *Working in an interdisciplinary environment* *Production of new research ideas*	*Respect for 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. Basic properties of polymers and colloids

2. Develop critical and creative thinking

3. Develop design criteria to tailor material properties

4. Individual project or term paper to test the above skills.

(3) SYLLABUS

1. Basics of soft matter: molar mass, length, time and energy scales, entropy, Brownian motion

2. Classification: macromolecular architecture, copolymers, supramolecular polymers, soft and hard colloids, shape effects.

3. Ideal polymers, sizes, distributions, entropy elasticity

4. Real polymers, excluded volume

5. Polymer blends, solutions: miscibility

6. Dynamics, coarse graining. Bead-spring models. Rouse, reptations.

7. Linear viscoelasticity

8. Colloidal interactions, volume fraction

9. Diffusion and viscosity

10. Colloidal phase diagrams, gels and glasses

11. Non-spherical colloids and mixtures

(4) TEACHING and LEARNING METHODS - EVALUATION

<table>
<tr><td>DELIVERY
Face-to-face, Distance learning, etc.</td><td>Face-to-face</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
Use of ICT in teaching, laboratory education, communication with students</td><td>Use of educational videos, use of open-source software with example data, online mathematical tools for solving/plotting solutions. Use of e-class for distribution of lecture notes, videos, links, questionnaires, suggested and solved exercises.</td></tr>
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<tr><th>Activity</th><th>Semester workload</th></tr>
<tr><td>Lectures</td><td>31</td></tr>
<tr><td>Exercise section</td><td>8</td></tr>
<tr><td>Office hours</td><td>26</td></tr>
<tr><td>Optional Project</td><td>(15)</td></tr>
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Description of the evaluation procedure

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

Specifically-defined evaluation criteria are given, and if and where they are accessible to students.</td><td>Formative (Assessment of progress without grade consequence)
- Weekly suggested exercises
- Oral participation in solving problems during lectures

Conclusive (Evaluation with grading consistency)
- One midterm
- Project or term paper (optional)
- Final written exam

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

(5) ATTACHED BIBLIOGRAPHY

- *Suggested bibliography:*

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

J. Mewis, N. J. Wagner, Colloidal suspension rheology, Cambridge, 2011.

N. J. Wagner, J. Mewis, Theory and applications of colloidal suspension rheology, Cambridge, 2021.

R. A. L. Jones, Soft condensed matter, Oxford, 2002.

SM9 Mechanics of soft materials: rheology, processing and mechanical properties

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIAL SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	SM9	**SEMESTER**	2
COURSE TITLE	Mechanics of soft materials: rheology, processing and mechanical properties		
INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*		**WEEKLY TEACHING HOURS**	**CREDITS**
		3	5
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).			
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Special background		
PREREQUISITE COURSES:			
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	English		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes		
COURSE WEBSITE (URL)	https://www.materials.uoc.gr		

(2) LEARNING OUTCOMES

Learning outcomes

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

Consult Appendix A

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

Upon completion of the course, the graduate students are expected to:

1. understand the basic properties involved in the flow, mechanical properties and processing of soft materials
2. use their knowledge to develop criteria for tailoring/improving the rheology and processability of soft materials
3. select materials with anticipated response in specific applications

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*
	Respect for the natural environment

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

1. Main rheological features of soft materials

2. Combine knowledge from properties of different classes (polymers, colloids) to understand flow properties of composites

3. Develop design criteria to improve processing of soft materials

4. Individual project or term paper to test the above skills.

(3) SYLLABUS

1. A primer on rheology: stress and deformation tensors, Newton's and Hooke' laws, shear and extension

2. Linear viscoelasticity, Boltzmann's superposition, time-temperature superposition

3. Nonlinear rheological phenomena

3. Rheometry, shear thinning/thickening, extension hardening, instabilities

4. Mechanical models, constitutive equations

5. Examples of processing flows and link to material properties (extrusion, calendaring, blow molding)

6. Adhesion and fracture of soft materials

7. Experimental tests (optional)

(4) TEACHING and LEARNING METHODS - EVALUATION

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<tr><td>Office hours</td><td>26</td></tr>
<tr><td>Optional Project</td><td>(15)</td></tr>
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Description of the evaluation procedure

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

Specifically-defined evaluation criteria are given, and if and where they are accessible to students.</td><td>Formative (Assessment of progress without grade consequence)
- Weekly suggested exercises
- Oral participation in solving problems during lectures

Conclusive (Evaluation with grading consistency)
- One midterm
- Project or term paper (optional)
- Final written exam

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

(5) ATTACHED BIBLIOGRAPHY

- *Suggested bibliography:*

R. G. Larson, Structure and rheology of complex fluids, Oxford, 1999

W. W. Graessley, Polymeric liquids and networks: dynamics and rheology, Garland, 2008

R. I. Tanner, Engineering rheology, 2nd ed., Oxford, 2000

C. W. Macosko, Rheology: principles, measurements and applications, Wiley, 1994

R. Long, C-Y. Hui, J. P. Gong, E. Bouchbinder, The Fracture of Highly Deformable Soft Materials: A Tale of Two Length Scales, Annual Review of Condensed Matter Physics 12:71-94, 2021

C. Creton, C. Ciccotti, Fracture and adhesion of soft materials: a review, Rep. Prog. Phys. 79 (2016) 046601

SM10 Soft matter seminar

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIAL SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	SM10	**SEMESTER**	2
COURSE TITLE	Soft matter seminar		

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

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

(2) LEARNING OUTCOMES

Learning outcomes

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

Consult Appendix A

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

Upon completion of the course, the graduate students are expected to:

1. have a broad overview of current trends and challenges in soft materials research.

2. understand the importance of soft materials in contemporary societal challenges (environment, energy, circular economy, biomedicine)

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…* *…….*

1. Obtain a grasp of critical soft material properties for different applications

2. Develop critical and creative thinking

3. Individual term paper to test the above skills.

(3) SYLLABUS

1. Weakly seminars by experts in different types/applications of soft materials

2. Presentation skills

3. Reporting skills

4. Criteria for assessing presentations

(4) TEACHING and LEARNING METHODS - EVALUATION

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<tr><td>DELIVERY
Face-to-face, Distance learning, etc.</td><td>Face-to-face</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
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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.

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<tr><th>Activity</th><th>Semester workload</th></tr>
<tr><td>Lectures</td><td>26</td></tr>
<tr><td>Exercise section</td><td>13</td></tr>
<tr><td>Office hours</td><td>26</td></tr>
<tr><td>Optional Project</td><td></td></tr>
<tr><td>Independent study</td><td>60</td></tr>
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<tr><td>STUDENT PERFORMANCE EVALUATION
Description of the evaluation procedure

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

Specifically-defined evaluation criteria are given, and if and where they are accessible to students.</td><td>Formative (Assessment of progress without grade consequence)
- Weekly suggested exercises
- Oral participation in solving problems during lectures

Conclusive (Evaluation with grading consistency)
- Term paper
- Final oral exam

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

(5) ATTACHED BIBLIOGRAPHY

- *Suggested bibliography:*

W. van Saarloos, V. Vitelli, Z. Zeravcic, Soft Matter: concepts, phenomena and applications, Princeton, 2024.

I.W. Hamley, Introduction to soft matter, revised ed., Wiley, 2007.

T.C. B. McLeish, Soft matter: a very short introduction, Oxford, 2020.

SM12 Soft Computational methods in soft matter

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIAL SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	SM12	**SEMESTER**	2
COURSE TITLE	Computational methods in soft matter		

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

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

(2) LEARNING OUTCOMES

Learning outcomes

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

Consult Appendix A

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

Upon completion of the course, the graduate students are expected to:

1. have developed a good understanding of the key principles of equilibrium statistical mechanics (theory of statistical ensembles)

2. be familiar with the basic methods of computation at different levels (molecular dynamics, Brownian dynamics, dissipative particle dynamics, Monte Carlo) in various ensembles

3. have developed a background on coarse graining and reverse mapping techniques

4. properly use software packages (e.g., LAMMPS, GROMACS, Chameleon)

4. apply new knowledge and skills to solve simple problems in soft matter with the help of the computational tools developed in the course

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…*
	…….

1. quantitative analysis using appropriate tools (software packages). For example, given a classical trajectory from such a simulation, to compute thermodynamic and structural properties of the system of interest, also to use fundamental theorems of classical statistical mechanics to compute time autocorrelation and cross-correlation functions and extract from them important transport properties (e.g., viscosity and diffusivity).

2. develop critical and creative thinking – address phenomena at the microscopic level and connect them with macroscopic observables

3. Select and work with different ensembles, depending on the problem in question. Combine information from different areas and extract the punchline in a given problem.

(3) SYLLABUS

1. Introduction to statistical mechanics.
2. Introduction to molecular simulations.
3. Molecular Dynamics. Microscopic dynamical equations in the NVT, NVE and NPT ensembles.
4. The trajectory file and its post-processing. Radial pair correlation functions, time auto-correlation and cross-correlation functions.
5. Non-Equilibrium Molecular Dynamics.
6. Monte Carlo sampling. Monte Carlo moves for chain-like systems.
7. Free energies and phase equilibria. Widom test particle insertion.
8. Multiscale modelling. Coarse-graining, Dissipative particle dynamics and hydrodynamics, Brownian dynamics.
9. Special topics: Fluctuations and their role in determining thermodynamic properties. Rare events, Transition state theory. Mapping of simulation results to molecular theories of Soft Matter (Rouse model, Zimm model, reptation theory).
10. Examples: I. Application of molecular simulations to polymer melts and polymer nanocomposites. II. Application of molecular simulation tools to polymer solutions, colloids, micellar surfactants, and other complex systems in Soft Matter.

(4) TEACHING and LEARNING METHODS - EVALUATION

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<tr><td>Exercise section</td><td>9</td></tr>
<tr><td>Office hours</td><td>26</td></tr>
<tr><td>Optional Project</td><td></td></tr>
<tr><td>Independent study</td><td>60</td></tr>
<tr><td>Course total</td><td>125</td></tr>
</table>
</td></tr>
<tr><td>STUDENT PERFORMANCE EVALUATION
Description of the evaluation procedure

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

Specifically-defined evaluation criteria are given, and if and where they are accessible to students.</td><td>Formative (Assessment of progress without grade consequence)
- Weekly suggested exercises
- Oral participation in solving problems during lectures

Conclusive (Evaluation with grading consistency)
- One midterm
- Final written exam

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

(5) ATTACHED BIBLIOGRAPHY

- *Suggested bibliography:*

D.A. McQuarrie, Statistical Mechanics (Harper and Row: New York, 1976).

D. Frenkel, B. Smit, Understanding molecular simulation: From algorithms to applications (Academic Press, 2002).

M.P. Allen, D.J. Tildesley, Computer Simulation of liquids (Oxford Science Publications, Oxford, 1997).

D.N. Theodorou, V.G. Mavrantzas, Multiscale modelling of Polymers (Oxford Univ. Press, Oxford, 2024), in preparation.

SM14 Soft biomaterials for biomedical applications

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIAL SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	SM14	**SEMESTER**	2
COURSE TITLE	Soft biomaterials for biomedical applications		

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

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

(2) LEARNING OUTCOMES

Learning outcomes

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

Consult Appendix A

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

Upon completion of the course, the graduate students are expected to:

1. distinguish biomaterials from synthetic materials

2. use their knowledge to understand the main features of biological materials in different functions (regenerative medicine, drug delivery)

3. understand the role of interactions and molecular features of specific biomaterials in different applications

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…*
	…….

1. Basic types of biomaterials and biological interactions

2. Develop critical and creative thinking

3. Critical assessment of biological interactions.

4. Individual term paper to test the above skills.

(3) SYLLABUS

1. Synthetic, nature-inspired and natural biomaterials

2. Fabrication and mechanical properties of 3D scaffolds

3. Properties and applications of biomaterials in nanomedicine

4. Properties and applications of biomaterials in tissue engineering

5. Regeneration of skin, peripheral nerves, spinal cord, conjunctiva, myocardium

6. Properties and applications of biomaterials in biosensors

7. Special topics on biocompatibility and regulatory pathway.

(4) TEACHING and LEARNING METHODS - EVALUATION

<table>
<tr><td>DELIVERY
Face-to-face, Distance learning, etc.</td><td>Face-to-face</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
Use of ICT in teaching, laboratory education, communication with students</td><td>Use of educational videos, use of open-source software with example data, online mathematical tools for solving/plotting solutions. Use of e-class for distribution of lecture notes, videos, links, questionnaires, suggested and solved exercises.</td></tr>
<tr><td>TEACHING METHODS
The manner and methods of teaching are described in detail.
Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.

The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS</td><td>
<table>
<tr><th>Activity</th><th>Semester workload</th></tr>
<tr><td>Lectures</td><td>39</td></tr>
<tr><td>Exercise section</td><td></td></tr>
<tr><td>Office hours</td><td>26</td></tr>
<tr><td>Optional Project</td><td>(15)</td></tr>
<tr><td>Independent study</td><td>60</td></tr>
<tr><td>Course total</td><td>125 (140)</td></tr>
</table>
</td></tr>
<tr><td>STUDENT PERFORMANCE EVALUATION
Description of the evaluation procedure

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

Specifically-defined evaluation criteria are given, and if and where they are accessible to students.</td><td>Formative (Assessment of progress without grade consequence)
- Weekly suggested exercises
- Oral participation in solving problems during lectures

Conclusive (Evaluation with grading consistency)
- One midterm
- Term paper (optional)
- Final written exam

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

(5) ATTACHED BIBLIOGRAPHY

- *Suggested bibliography:*

C. M. Agrawal, J. L. Ong, M. R. Appleford, G. Mani, Introduction to biomaterials, Cambridge 2014.

I.V. Yannas, Tissue and organ regeneration in adults. Extension of the paradigm to several organs. Springer, 2015.

De Witte et al. Bone tissue engineering via growth factor delivery: from scaffolds to complex matrices, Regenerative Biomaterials, 2018, 1–15, doi: 10.1093/rb/rby013.

Thibault et al. Scaffold/Extracellular Matrix Hybrid Constructs for Bone-Tissue Engineering, Adv. Healthcare Mater. 2013, 2, 13–24, doi: 10.1002/adhm.201200209.

Engineering biocompatible implant surfaces Part I: Materials and surfaces, Progress in Materials Science 58 (2013) 261–326, http://dx.doi.org/10.1016/j.pmatsci.2012.09.001.

Engineering biocompatible implant surfaces Part II: Cellular recognition of biomaterial surfaces: Lessons from cell–matrix interactions, Progress in Materials Science 58 (2013) 327–381, http://dx.doi.org/10.1016/j.pmatsci.2012.09.002.

Perera, A.S. and Coppens-M.O. Re-designing materials for biomedical applications: from biomimicry to nature-inspired chemical engineering Phil. Trans. R. Soc. A 377 (2019): 20180268, http://dx.doi.org/10.1098/rsta.2018.0268.

SM15 Advanced topics I

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIAL SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	SM15	**SEMESTER**	2
COURSE TITLE	Advanced topics I (examples: responsive materials, mechanochemistry, supramolecular chemistry, sustainable polymers)		

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

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

(2) LEARNING OUTCOMES

Learning outcomes

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

Consult Appendix A

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

Upon completion of the course, the graduate students are expected to:

1. understand the basic features associated with the topics covered (e.g., responsive materials, mechanochemistry, supramolecular chemistry, sustainable polymers)

2. use their knowledge to discern materials (e.g., responsive materials from polymer thermal transitions in the bulk or sustainable from synthetic polymers) and consider applications related to the topics covered

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…*
	…….

1. Main features/properties of the topic covered

2. Develop critical and creative thinking

3. Develop design criteria to tailor material properties

4. Individual project or term paper to test the above skills.

(3) SYLLABUS

1. Responsive polymers: polymers responding to physical, chemical and biochemical stimuli

2. Mechanism of response and effect on the materials properties

3. Basic principles of mechanochemistry in polymeric materials. Design and study of mechanophores

4. Selected mechanoresponsive polymers: comparison of properties and perspectives

5. Polymer self-assembly mechanisms: intermolecular interactions/host-guest interactions

6. Supramolecular assemblies and hierarchical superstructures: types and properties

7. Biobased monomers and polymers. Green material processing

8. Biocomposites: synthesis, properties and applications

9. Special topics (depending on students' interests)

TEACHING and LEARNING METHODS - EVALUATION

<table>
<tr><td>DELIVERY
Face-to-face, Distance learning, etc.</td><td>Face-to-face</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
Use of ICT in teaching, laboratory education, communication with students</td><td>Use of educational videos, use of open-source software with example data, online mathematical tools for solving/plotting solutions. Use of e-class for distribution of lecture notes, videos, links, questionnaires, suggested and solved exercises.</td></tr>
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<table>
<tr><th>Activity</th><th>Semester workload</th></tr>
<tr><td>Lectures</td><td>29</td></tr>
<tr><td>Exercise section</td><td>10</td></tr>
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<tr><td>Optional Project</td><td>(15)</td></tr>
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<tr><td>STUDENT PERFORMANCE EVALUATION
Description of the evaluation procedure

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

Specifically-defined evaluation criteria are given, and if and where they are accessible to students.</td><td>Formative (Assessment of progress without grade consequence)
- Weekly suggested exercises
- Oral participation in solving problems during lectures

Conclusive (Evaluation with grading consistency)
- One midterm
- term paper (optional)
- Final written exam

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

(4) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

Class notes and research papers/reviews for each topic covered

SM18 Course from other Departments

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIAL SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	SM18	**SEMESTER**	2
COURSE TITLE	Course from other Departments		

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

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Special background
PREREQUISITE COURSES:	Depends on course
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	English
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Depends on course
COURSE WEBSITE (URL)	https://www.materials.uoc.gr (lists courses offered from other Departments each semester)

(2) LEARNING OUTCOMES

Learning outcomes

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

Consult Appendix A

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

Upon completion of the course, the graduate students are expected to:

1. be familiar with main concepts developed in the course
2. understand the usefulness of the taught topic in soft material 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
Team work
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

Working in an international environment *Working in an interdisciplinary environment* *Production of new research ideas*	*Production of free, creative and inductive thinking* *……* *Others…* *…….*

1. Use elements/concepts taught in the course to understand or predict soft materials properties
2. Individual term paper to test the above skills

(3) SYLLABUS

Specific for each course

TEACHING and LEARNING METHODS - EVALUATION

<table>
<tr><td>DELIVERY
Face-to-face, Distance learning, etc.</td><td>Face-to-face</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
Use of ICT in teaching, laboratory education, communication with students</td><td>Use of educational videos, use of open-source software with example data, online mathematical tools for solving/plotting solutions. Use of e-class for distribution of lecture notes, videos, links, questionnaires, suggested and solved exercises.</td></tr>
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The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS</td><td><table><tr><th>Activity</th><th>Semester workload</th></tr><tr><td>Lectures</td><td>29</td></tr><tr><td>Exercise section</td><td>10</td></tr><tr><td>Office hours</td><td>26</td></tr><tr><td>Optional Project</td><td></td></tr><tr><td>Independent study</td><td>60</td></tr><tr><td>Course total</td><td>125</td></tr></table></td></tr>
<tr><td>STUDENT PERFORMANCE EVALUATION
Description of the evaluation procedure

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

Specifically-defined evaluation criteria are given, and if and where they are accessible to students.</td><td>Formative (Assessment of progress without grade consequence)
- Weekly suggested exercises
- Oral participation in solving problems during lectures

Conclusive (Evaluation with grading consistency)
- One midterm
- term paper (optional, depending on course)
- Final written exam

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

(4) ATTACHED BIBLIOGRAPHY

- *Suggested bibliography:*

Specific for each course

2nd YEAR

SM_RT Research thesis

(1) GENERAL

SCHOOL	SCIENCES AND ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIAL SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	SM RT	**Year**	2
COURSE TITLE	Research thesis		
INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*		**WEEKLY TEACHING HOURS**	**CREDITS**
			60
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:			
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	English		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes		
COURSE WEBSITE (URL)	https://www.materials.uoc.gr		

(2) LEARNING OUTCOMES

Learning outcomes

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

Consult Appendix A

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

Upon completion of the course, the graduate students are expected to:

1. be able to undertake, run and complete, as well as present a research project

2. develop and articulate their own ideas

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 *Working in an international environment* *Working in an interdisciplinary environment* *Production of new research ideas*	*Criticism and self-criticism* *Production of free, creative and inductive thinking* *……* *Others…* *…….*

1. Independent work

2. Combine complementary information into a cohesive story

(3) SYLLABUS

1. Thesis topic (provided by supervisor): understand the challenges, read literature

2. Divide work into tasks, work on each task

3. Analyze and interpret results

4. Write thesis

5. Present thesis

TEACHING and LEARNING METHODS - EVALUATION

<table>
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<tr><td>Office hours</td><td></td></tr>
<tr><td>Optional Project</td><td></td></tr>
<tr><td>Independent study</td><td>1500</td></tr>
<tr><td>Course total</td><td>1500</td></tr>
</table>
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<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

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- Weekly suggested exercises
- Oral participation in solving problems during lectures

Conclusive (Evaluation with grading consistency)
- Final thesis
- Final oral exam

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

(4) ATTACHED BIBLIOGRAPHY

- *Suggested bibliography:*

Literature to be searched, acquired and studied by the student