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## 1<sup>st</sup> Semester

### Introduction to Materials Science and Engineering

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	<b>MSEN 101</b>	<b>SEMESTER</b>	1st Semester
<b>COURSE TITLE</b>	<b>Introduction to Materials Science and Engineering</b>		
<b>TEACHING ACTIVITIES</b>	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>	
Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	4 (3L + 1T)	6	
<b>COURSE TYPE</b>	Background / General knowledge / Scientific area		
<b>PREREQUISITES</b>	None. Recommended: high-school Chemistry and Physics; basic Calculus.		
<b>TEACHING AND EXAMINATION METHODS</b>	Face-to-face lectures and guided problem-solving sessions; short in-class quizzes; final written examination.		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes (taught in English, subject to minimum enrollment).		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<ul style="list-style-type: none"> <li>• Explain the structure-processing-properties-performance paradigm in Materials Science and Engineering.</li> <li>• Describe bonding, crystal structures, and common defects, and relate them to macroscopic properties.</li> <li>• Interpret basic phase diagrams and use them to rationalize microstructure evolution.</li> <li>• Compare metals, ceramics, polymers, semiconductors, and composites in terms of key properties and applications.</li> <li>• Select simple characterization and testing methods appropriate for a given materials problem.</li> <li>• Communicate materials-related technical information using correct terminology and clear engineering reasoning.</li> </ul>
<b>General Skills</b>	<ul style="list-style-type: none"> <li>• Problem solving with quantitative reasoning</li> <li>• Teamwork in tutorial and lab-style activities</li> <li>• Information literacy (handbooks, databases, standards awareness)</li> <li>• Technical reporting and oral communication</li> <li>• Ethics and sustainability awareness in materials choices</li> </ul>

### 3. COURSE CONTENT

- What is Materials Science and Engineering: the materials paradigm and design trade-offs.
- Materials classes and typical applications; introduction to microstructure.
- Atomic bonding, crystal structures, and amorphous solids.
- Crystal defects: vacancies, dislocations, grain boundaries; diffusion basics.
- Phase diagrams: phases, lever rule, eutectic; intro to phase transformations.
- Mechanical behavior: elastic/plastic deformation, strengthening mechanisms, fracture basics.
- Functional properties overview: electrical, thermal, magnetic, optical; corrosion basics.
- Introduction to processing routes: casting, deformation processing, heat treatment, polymer processing, sintering, additive manufacturing (overview).
- Intro to materials selection concepts and sustainability considerations.

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face. Lectures, guided problem sessions, short demonstrations, and small-group activities/case studies.	
<b>Use of ICT</b>	Learning management system (e-learning platform) for notes, quizzes and announcements; spreadsheets for simple property charts; basic use of materials databases for information retrieval.	
<b>Teaching organization</b>	The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).	
	<b>Activity</b>	<b>Workload/semester (hours)</b>
	Lectures	39
	Tutorials / problem sessions	13
	Short assignments / quizzes	10
	Independent study	70
	Exam preparation	16
	Final written exam	2
<b>Total</b>	<b>150</b>	
<b>Student evaluation</b>	Assessment language: English. Methods: written final exam (60%), homework/problem sets and short quizzes (25%), mini-case study/report (15%). Students are informed via the course guide and e-learning announcements.	

### 5. SUGGESTED BIBLIOGRAPHY

#### EUDOXUS

To be specified in EUDOXUS.

#### Additional bibliography for study

- W.D. Callister & D.G. Rethwisch, Materials Science and Engineering: An Introduction.
- M.F. Ashby & D.R.H. Jones, Engineering Materials 1–2.
- J.F. Shackelford, Introduction to Materials Science for Engineers.
- Selected open courseware notes (indicative): MIT OCW / UC Berkeley MSE course materials.

## Fundamentals of Chemistry

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	<b>MSEN 102</b>	<b>SEMESTER</b>	1 <sup>st</sup> Semester
<b>COURSE TITLE</b>	<b>Fundamentals of Chemistry</b>		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		4 (3L + 1T)	6
<b>COURSE TYPE</b>	Background / General knowledge / Scientific area		
<b>PREREQUISITES</b>	None. Recommended: high-school Chemistry and Physics; basic Calculus.		
<b>TEACHING AND EXAMINATION METHODS</b>	Face-to-face lectures and guided problem-solving sessions; short in-class quizzes; final written examination.		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes.		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p>Upon successful completion of this course, students will be able to:</p> <ul style="list-style-type: none"> <li>• Demonstrate fundamental knowledge across organic, inorganic, and physical chemistry</li> <li>• Apply chemical principles to explain structure, bonding, reactivity, and properties of matter</li> <li>• Interpret experimental and spectroscopic data</li> <li>• Develop problem-solving and analytical skills appropriate for undergraduate chemistry</li> </ul> <p>By the end of this course, students will be able to:</p> <ul style="list-style-type: none"> <li>• Explain the nuclear model of the atom, the nature of electromagnetic radiation, and the basic quantum concepts related to atomic structure.</li> <li>• Describe atomic orbitals, quantum numbers, electron spin, and the electronic structure of both hydrogen and many-electron atoms.</li> </ul>

- Relate electronic structure to the periodic table and interpret major periodic trends such as atomic/ionic radii, ionization energies, and electron affinity.
  - Summarize the fundamental models of chemical bonding: ionic bonding, covalent bonding and Lewis structures, VSEPR geometry, valence-bond theory, and molecular-orbital theory.
  - Explain the molecular basis of the gaseous, liquid, and solid states of matter and relate macroscopic properties to intermolecular interactions.
  - Describe ideal and real gas behavior and interpret deviations from ideality using qualitative models.
  - Interpret phase diagrams and explain phase transitions in one- and two-component systems.
  - Explain the interaction of electromagnetic radiation with matter and relate energy quantization to molecular energy levels.
  - Distinguish between rotational, vibrational, and electronic molecular transitions and the regions of the electromagnetic spectrum in which they occur.
  - Describe the behavior of electrolytes in solution, including ion formation, solvation, and ionic interactions.
  - Explain deviations from ideal behavior in electrolyte solutions using the concepts of ionic strength and activity.
- By the end of this course, students will acquire skills to:
- Write electron configurations for atoms and ions and use them to rationalize periodic trends and chemical behavior.
  - Construct Lewis structures, evaluate resonance and formal charges, and predict molecular shapes using VSEPR.
  - Assess bond type, polarity, and approximate bond strengths based on electronegativity and bonding models.
  - Apply valence-bond and molecular-orbital theory to simple diatomic and small polyatomic molecules to determine bond order, magnetic properties, and qualitative bonding features.
  - Apply gas laws and simple equations of state to calculate and predict properties of gases under different conditions.
  - Analyze phase diagrams to determine stable phases and phase transitions as a function of temperature and pressure.
  - Interpret basic IR, Raman, and UV–Vis spectra to extract information about molecular structure and bonding.
  - Relate spectroscopic features to rotational, vibrational, and electronic energy level changes in molecules.

	<ul style="list-style-type: none"> <li>• Calculate and apply ionic strength and activity coefficients to describe non-ideal electrolyte solutions.</li> <li>• Use conductivity and colligative property concepts to assess electrolyte behavior in solution. understand the concept of organic molecules.</li> <li>• recognize the chemical structural unit of several basic organic materials.</li> <li>• understand the mechanisms of fundamental organic reactions.</li> <li>• realize the chemical properties and reactions of basic organic moieties.</li> </ul> <p>By the end of the course, students will be able to:</p> <ul style="list-style-type: none"> <li>• Integrate atomic and bonding principles to interpret the structure and reactivity of simple inorganic and molecular systems relevant to materials chemistry.</li> <li>• Choose appropriate bonding models (Lewis, VSEPR, valence-bond and molecular-orbital theory) to explain observed or predicted molecular properties.</li> <li>• Communicate concepts of atomic structure and bonding clearly using correct chemical terminology and representations.</li> <li>• Integrate concepts of states of matter, spectroscopy, and electrolyte solutions to explain physical and chemical properties of molecular systems.</li> <li>• Select appropriate physical chemistry models to interpret experimental observations and molecular behavior.</li> <li>• Evaluate the limitations of idealized models (ideal gases, ideal solutions) and justify the use of more realistic descriptions.</li> <li>• Communicate physical chemistry concepts clearly using correct scientific terminology, equations, graphs, and spectra.</li> </ul>
<p><b>General Skills</b></p>	<ul style="list-style-type: none"> <li>• Problem solving with quantitative reasoning</li> <li>• Teamwork in tutorial and lab-style activities</li> <li>• Information literacy (handbooks, databases, standards awareness)</li> <li>• Technical reporting and oral communication</li> <li>• Searching, analyzing and synthesizing data and information</li> <li>• Decision-making</li> <li>• Independent work</li> <li>• Teamwork</li> <li>• Promoting free, creative and inductive thinking</li> <li>• Working in a multidisciplinary environment</li> </ul>

### 3. COURSE CONTENT

#### Part 1 – Introductory Inorganic Chemistry

- The nuclear model of the atom; Electromagnetic radiation; Atomic spectra
- Radiation, quanta, and photons; The wave-particle duality of matter; The uncertainty principle; Wavefunctions and energy levels
- The principal quantum number; Atomic orbitals; Electron spin; Electronic structure of hydrogen
- Orbital energies; The building-up principle; Electronic structure of many-electron atoms and the periodic table
- The periodicity of atomic properties - Atomic radius; Ionic radius; Ionization energy; Electron affinity; The inert-pair effect; Diagonal relationships; The general properties of the elements
- Ionic bonds - Lewis symbols of ions; The energetics of ionic bond formation; Interactions between ions
- Covalent bonds - Lewis structures; Resonance; Formal charge; Radicals; Expanded and incomplete valence shells; Electronegativity and polarizability; Bond strengths and lengths
- The VSEPR Model
- Valence-bond theory - Sigma and pi Bonds; Hybridization of orbitals; Characteristics of multiple bonds
- Molecular orbital theory - Molecular orbitals; Electron configurations of diatomic molecules; Bonding in homonuclear and heteronuclear diatomic molecules; Orbitals in polyatomic molecules
- Introduction to the solid state – Covalent network structures; Structures based on the packing of spheres; Metallic bonding; Ionic bonding and lattice enthalpy
- Acids and bases – Brønsted-Lowry acids and bases; Lewis acids and bases

#### Part 2 – Introductory Physical chemistry

- States of matter – Gases, liquids, and solids; Macroscopic and molecular descriptions of matter
- The gaseous state – Ideal gas laws; Kinetic molecular theory of gases; Molecular speed distributions; Deviations from ideal behavior and real gases
- Intermolecular forces
- The liquid state – Structure of liquids; Viscosity; Surface tension; Vapor pressure
- The solid state – Crystalline and amorphous solids; Unit cells; Packing efficiency; Introduction to phase transitions
- Phase equilibria – Phase changes; Phase diagrams;
- Light matter interaction – The electromagnetic spectrum; Absorption and emission processes; Selection rules (qualitative)
- Molecular rotation – Rotational energy levels; Rotational spectra of diatomic molecules
- Molecular vibration – Vibrational energy levels; Infrared spectroscopy; Normal modes of vibration
- Raman spectroscopy – Raman scattering; Complementarity of IR and Raman spectroscopy
- Electronic transitions – UV-visible spectroscopy; Electronic excitation and molecular structure
- Spectroscopy as a structural tool – Qualitative interpretation of molecular spectra
- Electrolyte solutions – Formation of ions in solution; Solvation and hydration

- Strong and weak electrolytes – Degree of dissociation; Acid–base behavior in aqueous solution

Part 3 – Introductory Organic chemistry

- Structure and Bonding, Orbital Theories
- An Overview of Organic Molecules: Names and Properties
- An Overview of Organic Reactions
- Stereochemistry at Tetrahedral Centers
- Hydrocarbons: Alkanes, Alkenes and Alkynes, Stereochemistry
- Halogenoalkanes: Properties and reactivity.
- Nuclear Magnetic Resonance (NMR) Spectroscopic and its application in Materials.
- Benzene and Aromaticity, Polyaromatic compounds. Structure, properties.
- Characteristic Main Polar Groups in Organic Materials: Alcohols, Carbonyl Compounds, Acids, Amines.

#### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face.		
<b>Use of ICT</b>	ICT will be used in teaching the course, and in communication with students: <ul style="list-style-type: none"> <li>• teaching of the course with modern distance learning (ZOOM) and asynchronous education tools via elearning platform of AUTH,</li> <li>• communication with students via email, ZOOM, and elearning platform of AUTH.</li> </ul>		
<b>Teaching organization</b>	The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).		
	<b>Activity</b>	<b>Workload/semester (hours)</b>	<b>ECTS</b>
	Lectures	39	1.56
	Tutorials / problem sessions	13	0.52
	Bibliographic Research and analysis	10	0.4
	Independent study	70	2.8
	Exam preparation	16	0.64
	Final written exam	2	0.08
	<b>Total</b>	<b>150</b>	<b>6</b>
<b>Student evaluation</b>	<p><b>Assessment language</b> The assessment language is English.</p> <p><b>Assessment methods</b> The course uses the following methods:</p> <ul style="list-style-type: none"> <li>• <b>Multiple choice tests:</b> three midterm exams to check recall of definitions, concepts, and terminology on core concepts of chemistry.</li> <li>• <b>Problem solving assignments:</b> three written assignments in which students review course material, analyze literature data, and solve problems on fundamentals of chemistry.</li> <li>• <b>Final written exam:</b> it combines short answers, problem solving, and data interpretation questions to evaluate cumulative understanding on core concepts of chemistry.</li> </ul>		

	<p>Weighting</p> <ul style="list-style-type: none"> <li>• Multiple choice tests): 20%</li> <li>• Problem solving assignments: 20%</li> <li>• Final written exam: 60%</li> </ul> <p><b>Student information</b></p> <p>Students are informed about the assessment process through:</p> <ul style="list-style-type: none"> <li>• The course outline distributed in the first lecture.</li> <li>• Detailed instructions for the written assignment and presentation posted on the course website.</li> <li>• A dedicated assessment briefing during tutoring time where expectations and criteria are explained.</li> </ul>
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## 5. SUGGESTED BIBLIOGRAPHY

### Course Bibliography

Andrew Burrows, John Holman, Andrew Parsons, Gwen Pilling, Gareth Price, Chemistry<sup>3</sup>:  
Introducing inorganic, organic and physical chemistry

### Additional bibliography for study

- Teaching material slides

## Physics for Scientists and Engineers I – Mechanics & Waves

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	<b>MSEN 103</b>	<b>SEMESTER</b>	1 <sup>st</sup> Semester
<b>COURSE TITLE</b>	<b>Physics for Scientists and Engineers I – Mechanics &amp; Waves</b>		
<b>TEACHING ACTIVITIES</b>	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>	
Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	4	6	
<b>COURSE TYPE</b>	<p>Students will develop:</p> <ul style="list-style-type: none"> <li>A foundational understanding of the physical principles needed for later courses in physics, engineering, and applied sciences.</li> <li>Familiarity with the scientific method, evidence-based reasoning, and quantitative analysis, forming the conceptual groundwork for scientific problem-solving.</li> </ul> <p>Students will be able to:</p> <ul style="list-style-type: none"> <li>Understand and apply the principles of conservation (energy, momentum, angular momentum).</li> <li>Demonstrate an understanding of experimental measurement, units, and dimensional analysis.</li> </ul> <p>The course helps students develop important scientific and engineering skills such as:</p> <ul style="list-style-type: none"> <li>Translating physical situations into mathematical equations.</li> <li>Solving multi-step quantitative problems.</li> <li>Using calculus-based methods to analyze motion and waves.</li> </ul>		
<b>PREREQUISITES</b>	<p>Mathematics Background</p> <ul style="list-style-type: none"> <li>Calculus I (or concurrent enrollment)</li> </ul> <p>Students should understand:</p> <ul style="list-style-type: none"> <li>Limits and derivatives</li> <li>Basic integral concepts</li> <li>Algebraic manipulation and trigonometry</li> </ul> <p>Students benefit from prior exposure to:</p> <ul style="list-style-type: none"> <li>Newton's laws</li> <li>Basic kinematics</li> <li>Simple energy and momentum ideas</li> </ul> <p>Students should be able to:</p> <ul style="list-style-type: none"> <li>Apply mathematical reasoning</li> <li>Analyze graphs and quantitative data</li> <li>Solve multi-step problems</li> </ul>		
<b>TEACHING AND EXAMINATION METHODS</b>	Lectures, Written Assignments, eLearning quizzes, Written exams		
<b>COURSE OFFERED TO</b>	Yes.		

ERASMUS STUDENTS	
COURSE URL	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>

## 2. LEARNING OUTCOMES

<b>Learning Outcomes</b>	<p>By the end of the course, students will acquire:</p> <p><b>Conceptual Understanding:</b> Explain fundamental principles, Describe the physics of relative phenomena, Connect physical principles to real-world phenomena in science and engineering contexts.</p> <p><b>Analytical and Mathematical Skills:</b> Apply calculus-based methods to analyze, Solve multi-step physics problems using algebra, trigonometry, derivatives, and integrals</p> <p><b>Problem-Solving Abilities:</b> Break down complex physical scenarios into solvable components, Evaluate the validity of assumptions, approximations, and results.</p>
<b>General Skills</b>	<p>By the end of the course, students will acquire: <b>Communication Skills:</b></p> <p>Communicate scientific reasoning and solutions clearly in written and oral formats.</p> <p><b>Application and Transfer of Knowledge:</b> Apply mechanics and wave principles to engineering systems, materials, and everyday physical situations, Use physics concepts to predict system behavior and evaluate engineering design choices, Demonstrate readiness for advanced courses on Materials' Engineering.</p>

## 3. COURSE CONTENT

This course provides a foundational understanding of how objects move and interact, and how mechanical waves propagate. The course focuses on core principles that underpin all of classical mechanics and wave phenomena. It establishes the mathematical and conceptual tools needed for advanced physics and engineering.

## 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face.
<b>Use of ICT</b>	<p>ICT plays a significant role in enhancing teaching, learning, experimentation, visualization, and assessment in this course as follows:</p> <p><b>Computational Tools for Problem Solving:</b> Spreadsheet calculations (Excel, Google Sheets), Coding solutions in Python, MATLAB, or Mathematica</p> <p><b>Online Learning Platforms:</b> Learning management systems (LMS) like Moodle, Online lectures, video tutorials, and animations,</p>

	<p><b>Communication and Collaboration:</b> Online discussion forums, Collaborative documents, Sharing of data and reports</p> <ul style="list-style-type: none"> <li>• <b>Presentation and Reporting Tools:</b> Lab reports (word processors), Data plots and charts (graphing tools), Presentations (PowerPoint, Google Slides).</li> </ul>												
<b>Teaching organization</b>	<p>The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).</p> <table border="1"> <thead> <tr> <th>Activity</th> <th>Workload/semester (hours)</th> </tr> </thead> <tbody> <tr> <td>Lectures</td> <td>52</td> </tr> <tr> <td>self-study, quizzes, on-line tests</td> <td>48</td> </tr> <tr> <td>Independent study</td> <td>48</td> </tr> <tr> <td>Final written exam</td> <td>2</td> </tr> <tr> <td><b>Total</b></td> <td><b>150</b></td> </tr> </tbody> </table>	Activity	Workload/semester (hours)	Lectures	52	self-study, quizzes, on-line tests	48	Independent study	48	Final written exam	2	<b>Total</b>	<b>150</b>
Activity	Workload/semester (hours)												
Lectures	52												
self-study, quizzes, on-line tests	48												
Independent study	48												
Final written exam	2												
<b>Total</b>	<b>150</b>												
<b>Student evaluation</b>	<p>Assessment Language: English</p> <ul style="list-style-type: none"> <li>• Assessment Methods: Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Written Exams</li> </ul>												

## 5. SUGGESTED BIBLIOGRAPHY

### Course Bibliography

Principles & Practice of Physics | E. Mazur | (Volume 1) | ISBN 13: 978-0321949202 | Pearson 2014

### Additional bibliography for study

Principles & Practice of Physics | E. Mazur | (Volume 2) | ISBN: 978-0321957771 | Pearson 2014

## Mathematics I – Algebra, Analytic Geometry and Introduction to Calculus

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	<b>MSEN 104</b>	<b>SEMESTER</b>	1 <sup>st</sup> Semester
<b>COURSE TITLE</b>	<b>Mathematics I – Algebra, Analytic Geometry and Introduction to Calculus</b>		
<b>TEACHING ACTIVITIES</b> Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.		<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		4	6
<b>COURSE TYPE</b>	<p>Students will develop:</p> <ul style="list-style-type: none"> <li>• A foundational understanding of the physical principles needed for later courses in physics, engineering, and applied sciences.</li> <li>• Familiarity with the scientific method, evidence-based reasoning, and quantitative analysis, forming the conceptual groundwork for scientific problem-solving.</li> </ul> <p>Students will be able to:</p> <ul style="list-style-type: none"> <li>• Understand and apply the principles of conservation (energy, momentum, angular momentum).</li> <li>• Demonstrate an understanding of experimental measurement, units, and dimensional analysis.</li> </ul> <p>The course helps students develop important scientific and engineering skills such as:</p> <ul style="list-style-type: none"> <li>• Translating physical situations into mathematical equations.</li> <li>• Solving multi-step quantitative problems.</li> <li>• Using calculus-based methods to analyze motion and waves.</li> </ul>		
<b>PREREQUISITES</b>	<p>Mathematics Background</p> <ul style="list-style-type: none"> <li>• Calculus I (or concurrent enrollment)</li> </ul> <p>Students should understand:</p> <ul style="list-style-type: none"> <li>• Limits and derivatives</li> <li>• Basic integral concepts</li> <li>• Algebraic manipulation and trigonometry</li> </ul> <p>Students should be able to:</p> <ul style="list-style-type: none"> <li>• Apply mathematical reasoning</li> <li>• Analyze graphs and quantitative data</li> </ul> <p>Solve multi-step problems</p>		
<b>TEACHING AND EXAMINATION METHODS</b>	Lectures, Homework assignments, Quizzes (algebra, analytic geometry, differentiation), Midterm examination, Final exam		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes.		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p>Upon successful completion of course students will be able to:</p> <p>Apply algebraic methods to solve engineering problems involving equations, functions, and material property relationships.</p> <p>Use analytic geometry concepts—including lines, conic sections, and vectors—to model and interpret material structures and engineering systems.</p> <p>Demonstrate understanding of limits and continuity as foundations for describing rate-based physical and chemical processes.</p> <p>Compute and apply derivatives to analyze stress–strain behavior, optimize engineering processes, and model kinetics and diffusion.</p> <p>Perform basic integration to evaluate accumulated quantities such as work done in deformation, heat transfer, and mass transport.</p> <p>Interpret mathematical results and use quantitative reasoning to support analysis and decision-making in materials engineering contexts.</p>
<b>General Skills</b>	<p>By the end of the course, students will develop essential problem-solving, analytical thinking, and quantitative reasoning skills, gain the ability to communicate mathematical ideas clearly, use appropriate technical tools for modeling and visualization, and learn to connect mathematical methods to real materials engineering applications.</p>

3. COURSE CONTENT	
<p>This course builds the mathematical foundation required for advanced study in materials engineering, emphasizing algebraic methods, geometric interpretation, and introductory calculus tools used in material behavior modeling, structural analysis, and process calculations.</p> <ol style="list-style-type: none"> <li>1. Algebra (Engineering Foundations): Essential for material property calculations and processing equations. Applicable to stress–strain relationships, thermal expansion, and phase boundaries.</li> <li>2. Analytical Geometry for microstructure imaging, crystallography projections, and mechanical plotting, modeling stress distributions, heat transfer paths, and optical properties, crystallographic directions, force systems, and material deformation analysis.</li> <li>3. Introduction to Calculus: foundational for understanding rate-based material processes, Rates of change in thermal/chemical processes, Optimization in materials design and processing, identifying maximum strength points, minimum energy configurations, and analyzing dynamic systems. Accumulated change in heat or mass transport, Foundation for later courses in thermodynamics and transport phenomena</li> <li>4. Relevance to Materials Engineering: Students learn mathematical tools that support: Mechanical behavior and elasticity analysis, Diffusion and kinetics modeling. Thermal processes and phase transformation calculations, Data analysis from material testing, Engineering design and optimization</li> </ol>	

4. LEARNING & TEACHING METHODS - EVALUATION	
<b>Teaching method</b>	Face-to-face.
<b>Use of ICT</b>	<p>ICT plays a significant role in enhancing teaching, learning, experimentation, visualization, and assessment in this course as follows:</p> <p>Computational Tools for Problem Solving: Spreadsheet calculations (Excel, Google Sheets), Coding solutions in Python, MATLAB, or Mathematica</p>

	<p>Online Learning Platforms: Learning management systems (LMS) like Moodle, Online lectures, video tutorials, and animations,          Communication and Collaboration: Online discussion forums, Collaborative documents, Sharing of data and reports</p> <ul style="list-style-type: none"> <li>• Presentation and Reporting Tools: Lab reports (word processors), Data plots and charts (graphing tools), Presentations (PowerPoint, Google Slides).</li> </ul>												
<b>Teaching organization</b>	<p>The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).</p> <table border="1"> <thead> <tr> <th>Activity</th> <th>Workload/semester (hours)</th> </tr> </thead> <tbody> <tr> <td>Lectures</td> <td>52</td> </tr> <tr> <td>self-study, quizzes, on-line tests</td> <td>48</td> </tr> <tr> <td>Independent study</td> <td>48</td> </tr> <tr> <td>Final written exam</td> <td>2</td> </tr> <tr> <td><b>Total</b></td> <td><b>150</b></td> </tr> </tbody> </table>	Activity	Workload/semester (hours)	Lectures	52	self-study, quizzes, on-line tests	48	Independent study	48	Final written exam	2	<b>Total</b>	<b>150</b>
Activity	Workload/semester (hours)												
Lectures	52												
self-study, quizzes, on-line tests	48												
Independent study	48												
Final written exam	2												
<b>Total</b>	<b>150</b>												
<b>Student evaluation</b>	<p>Assessment Language: English</p> <ul style="list-style-type: none"> <li>• Assessment Methods: Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Written Exams</li> </ul>												

## 5. SUGGESTED BIBLIOGRAPHY

### Course Bibliography

Introductory Mathematics for Engineering Applications | ISBN: 978-1119604426 | Wiley 2021

### Additional bibliography for study

Technical Calculus with Analytic Geometry | ISBN: 978-0201711127 | Pearson 2001

## Materials Informatics

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	<b>MSEN 105</b>	<b>SEMESTER</b>	1st Semester
<b>COURSE TITLE</b>	<b>Materials Informatics</b>		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		4 (3L + 1T)	6
<b>COURSE TYPE</b>	Mandatory / Scientific area / Skills development		
<b>PREREQUISITES</b>	No prerequisites		
<b>TEACHING AND EXAMINATION METHODS</b>	Face-to-face lectures and guided problem-solving sessions; short in-class quizzes; final written examination.		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p>By the end of this course, students will be able to:</p> <ul style="list-style-type: none"> <li>Analyze a problem and design a solution (algorithm formulation).</li> <li>Develop structured, efficient, comprehensible, and reusable computer programs that solve specific problems or families of problems.</li> <li>Understand complex programs.</li> <li>Evaluate the efficiency of the solution (algorithm).</li> <li>Analyze data and create basic simulations.</li> </ul>
<b>General Skills</b>	<ul style="list-style-type: none"> <li>Search for, analysis and synthesis of data and information, with the use of the necessary technology</li> <li>Work autonomously</li> <li>Advance free, creative and causative thinking</li> <li>Adapting to new situations</li> <li>Decision-making</li> <li>Modeling and solving real-world problems</li> <li>Working in a multidisciplinary environment</li> </ul>

### 3. COURSE CONTENT

The Material Informatics course aims to cultivate computational problem-solving skills. Upon completion of the course, students should be able to use a computer for problem-solving, as well as for data analysis and the creation of basic simulations. More specifically, they should be able to theoretically analyze a problem, formulate a solution algorithm, and solve it practically by developing an appropriate computer program, adhering to fundamental programming principles.

The final grade is determined by examinations as well as the evaluation of assignments and projects. The course utilizes the MATLAB computational environment and programming language, while also including elements of Python.

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face.	
<b>Use of ICT</b>	Use of ICT in Course Teaching, Use of ICT in Communication with Students Description: Use of Information and Communication Technologies (ICT) in teaching the course with tools of modern distance learning (MS-Teams) and asynchronous education (e-learning). Use of learning aids based on ICT: Excel, Matlab, Python Use of ICT in student assessment: Electronic grading (e-learning). Use of ICT in communication with students: e-learning, email, MS-Teams.	
<b>Teaching organization</b>	The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).	
	<b>Activity</b>	<b>Workload/semester (hours)</b>
	Lectures	40
	Laboratory Work	12
	Project	80
	Exams	2
<b>Total</b>	<b>150</b>	
<b>Student evaluation</b>	Assessment language: English. Written Exams with Problem Solving with Short Answer / Written Exams with Problem Solving (Summative) / Oral Exams / Staging Laboratory Assignment	

### 5. SUGGESTED BIBLIOGRAPHY

#### EUDOXUS

1. Steven I. Gordon, Brian Guilfoos. (2017). Introduction to Modeling and Simulation with MATLAB and Python, Taylor and Francis Group.
2. Stormy Attaway. (2017). MATLAB, A Practical Introduction to Programming and Problem Solving, Elsevier

#### Additional bibliography for study

- Teaching material slides

## 2<sup>nd</sup> Semester

### Organic Chemistry

1. GENERAL			
SCHOOL	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
DEPARTMENT	Materials Science and Engineering		
LEVEL OF STUDIES	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
COURSE CODE	<b>MSEN 201</b>	SEMESTER	2 <sup>nd</sup> Semester
COURSE TITLE	<b>Organic Chemistry</b>		
TEACHING ACTIVITIES	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	TEACHING HOURS PER WEEK	ECTS CREDITS
		4	6
COURSE TYPE	Background and Scientific Area		
PREREQUISITES	No prerequisites		
TEACHING AND EXAMINATION METHODS	English		
COURSE OFFERED TO ERASMUS STUDENTS	Yes		
COURSE URL	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
Learning Outcomes	<p>By the end of this course, students will be able to:</p> <ul style="list-style-type: none"> <li>• understand the concept of organic molecules and materials.</li> <li>• recognize the repeating chemical structural unit of several basic organic materials.</li> <li>• understand the mechanisms of fundamental organic transformations/reactions.</li> <li>• develop fundamental organic reactions coordination.</li> <li>• realize the chemical properties and reactions of basic organic moieties.</li> <li>• Understand and recognize the main mechanistic pathways for organic reactions.</li> <li>• Acids, amines and their derivatives as precursors of organic materials synthesis.</li> </ul>
General Skills	<ul style="list-style-type: none"> <li>• Searching, analyzing and synthesizing data and information</li> <li>• Decision-making</li> <li>• Independent work</li> <li>• Teamwork</li> </ul>

	<ul style="list-style-type: none"> <li>• Generate new research ideas</li> <li>• Project planning and management emphasizing materials science</li> <li>• Promoting free, creative and inductive thinking</li> <li>• Modeling and solving real-world problems</li> <li>• Working in a multidisciplinary environment</li> </ul>
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### 3. COURSE CONTENT

<ol style="list-style-type: none"> <li>1. Structure and Bonding</li> <li>2. An Overview of Organic Reactions</li> <li>3. Stereochemistry at Tetrahedral Centers</li> <li>4. Hydrocarbons: Alkanes, Cycloalkanes and their Stereochemistry</li> <li>5. Hydrocarbons: Alkenes and Alkynes, Reactivity, Reactions, Stereochemistry and Synthesis</li> <li>6. Organohalides, Reactions of Alkyl Halides: Nucleophilic Substitutions and Eliminations</li> <li>7. Structure Determination: Spectroscopic and Chromatographic analysis</li> <li>8. Conjugated Compounds and Ultraviolet Spectroscopy</li> <li>9. Benzene and Aromaticity, Polyaromatic compounds: Electrophilic Aromatic Substitution</li> <li>10. Characteristic Polar Groups in Organic Materials</li> <li>11. Carbonyl compounds: Condensation Reactions-Anionic Polymerization</li> <li>12. Carboxylic Acids, Amines and their Derivatives</li> </ol>
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### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face.												
<b>Use of ICT</b>	<p>Use of ICT in Course Teaching, Use of ICT in Communication with Students</p> <p>Description: Use of Information and Communication Technologies (ICT) in teaching the course with tools of modern distance learning (ZOOM) and asynchronous education (eclass).</p> <p>Use of learning aids based on ICT: Excel, Word, Power Point</p> <p>Use of ICT in student assessment: Electronic grading (eclass, universis).</p> <p>Use of ICT in communication with students: eclass, email, ZOOM.</p>												
<b>Teaching organization</b>	<p>The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center;">Activity</th> <th style="text-align: center;">Workload/semester (hours)</th> </tr> </thead> <tbody> <tr> <td>Lectures</td> <td style="text-align: center;">52</td> </tr> <tr> <td>Bibliographic written, research and problem solving</td> <td style="text-align: center;">83</td> </tr> <tr> <td>Tutorial</td> <td style="text-align: center;">13</td> </tr> <tr> <td>Exams</td> <td style="text-align: center;">2</td> </tr> <tr> <td><b>Total</b></td> <td style="text-align: center;"><b>150</b></td> </tr> </tbody> </table>	Activity	Workload/semester (hours)	Lectures	52	Bibliographic written, research and problem solving	83	Tutorial	13	Exams	2	<b>Total</b>	<b>150</b>
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Lectures	52												
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Tutorial	13												
Exams	2												
<b>Total</b>	<b>150</b>												
<b>Student evaluation</b>	<p>Assessment Language: English</p> <p>Assessment Methods:</p> <ul style="list-style-type: none"> <li>• Short Answer Questions,</li> <li>• Essay Development Questions,</li> <li>• Multiple Choice Test</li> <li>• Problem Solving</li> <li>• Oral Exam</li> <li>• Written exams</li> </ul>												

## 5. SUGGESTED BIBLIOGRAPHY

### EUDOXUS

«Organic Chemistry» Ed. John McMurry, (9<sup>th</sup> Edition), ISBN 9781305080485

«Organic Chemistry» Ed. Marc Loudon and James Parise (Author, (6<sup>th</sup> Edition). ISBN-10: 1936221349, ISBN-13: 978-1936221349

### Additional bibliography for study

- Teaching material slides

## Fundamentals of Chemistry Laboratory

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	<b>MSEN 202</b>	<b>SEMESTER</b>	2 <sup>nd</sup> Semester
<b>COURSE TITLE</b>	<b>Fundamentals of Chemistry Laboratory</b>		
<b>TEACHING ACTIVITIES</b>	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>	
Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.			
	Lectures: 1 Lab work: 3 Total: 4	6	
<b>COURSE TYPE</b>	Background, General Knowledge		
<b>PREREQUISITES</b>	No prerequisites		
<b>TEACHING AND EXAMINATION METHODS</b>	English		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p>Upon successful completion of this course, students will be able to:</p> <ul style="list-style-type: none"> <li>• Fundamental knowledge across organic, inorganic, and physical chemistry</li> <li>• Understand the concept of inorganic and organic molecules, materials, their physicochemical properties</li> <li>• Practice on common techniques to clean and isolate inorganic and organic materials.</li> <li>• Practice on spectroscopy for structure determination of organic compounds and materials</li> <li>• These exercises are internationally and widely accepted and known and are taught in the first semester of studies in the Departments of Chemistry and Chemical Engineering.</li> </ul>
<b>General Skills</b>	<ul style="list-style-type: none"> <li>• Applying knowledge in practice</li> <li>• Searching, analyzing and synthesizing data and information, using the necessary spectroscopic technologies</li> <li>• Decision-making</li> </ul>

	<ul style="list-style-type: none"> <li>• Independent work</li> <li>• Teamwork</li> <li>• Generate new research ideas</li> <li>• Promoting free, creative and inductive thinking</li> </ul>
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### 3. COURSE CONTENT

- Laboratory safety rules, hazards of reagents, and techniques for measuring mass and volume. Expression of **solution** concentration and preparation of solutions with specified concentrations.
- Study of homogeneous and heterogeneous **equilibria**, including the effects of concentration and temperature. Equilibria in aqueous electrolyte solutions.
- Understand nature of **weak acids and bases**. **pH** and its measurement in aqueous solutions. **pK** of weak **acids and bases**. Preparation and evaluation of **buffer solutions** and their buffering capacity. Estimation of the hydrolysis constant of salts in aqueous solutions.
- Fundamentals and techniques of **volumetric analysis**. Preparation of standard solutions. Types of titrations: acid-base (acidimetry and alkalimetry), complexometric, and redox analysis.
- **Redox reactions** and the reactivity series of metals and non-metals. Oxidizing properties of common oxidants in aqueous solutions. Voltaic cells and electrolysis, including laws governing electrolysis and their applications.
- Recognize and use the **fundamental equipment** for **designing Organic Reaction**.
- Clean Organic liquid Materials via **Distillation techniques**. Isolation of clean low boiling organic materials.
- Isolation of different Acid/Base Organic Materials via **Extraction techniques**. Separation of a mixture of organic materials.
- Experimental investigation of the surface tension, viscosity, and refractive index of liquid systems, using standard physicochemical measurement techniques.
- Study of the effect of temperature on the solubility of solids in liquids, including construction and interpretation of solubility–temperature curves.
- Analysis of the relationship between molecular interactions and macroscopic properties such as flow behavior, interfacial phenomena, and optical response. Development of experimental skills in data collection, uncertainty estimation, and interpretation of physicochemical property measurements.

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face.
<b>Use of ICT</b>	<p>ICT will be used in teaching the course, and in communication with students:</p> <ul style="list-style-type: none"> <li>• teaching of the course with modern distance learning (ZOOM) and asynchronous education tools via elearning platform of AUTH,</li> <li>• communication with students via email, ZOOM, and elearning platform of AUTH.</li> </ul>

<b>Teaching organization</b>	The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).														
	<table border="1"> <thead> <tr> <th>Activity</th> <th>Workload/semester (hours)</th> </tr> </thead> <tbody> <tr> <td>Lectures</td> <td>13</td> </tr> <tr> <td>Bibliographic written, research and problem solving</td> <td>40</td> </tr> <tr> <td>Laboratory exercises</td> <td>39</td> </tr> <tr> <td>Writing of Assignments</td> <td>56</td> </tr> <tr> <td>Exams</td> <td>2</td> </tr> <tr> <td><b>Total</b></td> <td><b>150</b></td> </tr> </tbody> </table>	Activity	Workload/semester (hours)	Lectures	13	Bibliographic written, research and problem solving	40	Laboratory exercises	39	Writing of Assignments	56	Exams	2	<b>Total</b>	<b>150</b>
	Activity	Workload/semester (hours)													
	Lectures	13													
	Bibliographic written, research and problem solving	40													
	Laboratory exercises	39													
	Writing of Assignments	56													
	Exams	2													
<b>Total</b>	<b>150</b>														
<b>Student evaluation</b>	<p><b>Assessment language</b> The assessment language is English.</p> <p><b>Assessment methods</b> The course uses the following methods:</p> <ul style="list-style-type: none"> <li>• <b>Multiple choice tests:</b> two midterm exams to check recall of definitions, concepts, and terminology on core concepts on inorganic materials.</li> <li>• <b>Problem solving assignments:</b> two written assignments in which students review a class of inorganic materials, analyze literature data, and solve problems on inorganic materials.</li> <li>• <b>Final written exam:</b> it combines short answers, problem solving, and data interpretation questions to evaluate cumulative understanding on core concepts of inorganic materials.</li> </ul> <p>Weighting</p> <ul style="list-style-type: none"> <li>• Multiple choice tests): 20%</li> <li>• Problem solving assignments: 20%</li> <li>• Final written exam: 60%</li> </ul> <p><b>Student information</b> Students are informed about the assessment process through:</p> <ul style="list-style-type: none"> <li>• The course outline distributed in the first lecture.</li> <li>• Detailed instructions for the written assignment and presentation posted on the course website.</li> <li>• A dedicated assessment briefing during tutoring time where expectations and criteria are explained.</li> <li>•</li> </ul>														
<b>5. SUGGESTED BIBLIOGRAPHY</b>															
<b>EUDOXUS</b>															
Andrew Burrows, John Holman, Andrew Parsons, Gwen Pilling, Gareth Price, Chemistry <sup>3</sup> : Introducing inorganic, organic and physical chemistry															
<b>Additional bibliography for study</b>															
<ul style="list-style-type: none"> <li>• Teaching material slides</li> </ul>															

## Physics for Scientists and Engineers II– Electricity & Magnetism

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	<b>MSEN 203</b>	<b>SEMESTER</b>	2 <sup>nd</sup> Semester
<b>COURSE TITLE</b>	<b>Physics for Scientists and Engineers II– Electricity &amp; Magnetism</b>		
<b>TEACHING ACTIVITIES</b>	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>	
Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	4	6	
<b>COURSE TYPE</b>	<p>Students will develop:</p> <ul style="list-style-type: none"> <li>• A foundational understanding of the physical principles needed for later courses in physics, engineering, and applied sciences.</li> <li>• Familiarity with the scientific method, evidence-based reasoning, and quantitative analysis, forming the conceptual groundwork for scientific problem-solving.</li> </ul> <p>Students will be able to:</p> <ul style="list-style-type: none"> <li>• Understand and apply the principles of conservation (energy, momentum, angular momentum).</li> <li>• Demonstrate an understanding of experimental measurement, units, and dimensional analysis.</li> </ul> <p>The course helps students develop important scientific and engineering skills such as:</p> <ul style="list-style-type: none"> <li>• Translating physical situations into mathematical equations.</li> <li>• Solving multi-step quantitative problems.</li> <li>• Using calculus-based methods to analyze motion and waves.</li> </ul>		
<b>PREREQUISITES</b>	<p>Mathematics Background</p> <ul style="list-style-type: none"> <li>• Calculus I (or concurrent enrollment)</li> </ul> <p>Students should understand:</p> <ul style="list-style-type: none"> <li>• Limits and derivatives</li> <li>• Basic integral concepts</li> <li>• Algebraic manipulation and trigonometry</li> </ul> <p>Students benefit from prior exposure to:</p> <ul style="list-style-type: none"> <li>• Newton's laws</li> <li>• Basic kinematics</li> <li>• Simple energy and momentum ideas</li> </ul> <p>Students should be able to:</p> <ul style="list-style-type: none"> <li>• Apply mathematical reasoning</li> <li>• Analyze graphs and quantitative data</li> </ul> <p>Solve multi-step problems</p>		
<b>TEACHING AND EXAMINATION METHODS</b>	Lectures, Written Assignments, eLearning quizzes, Written exams		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes.		

<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>
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2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p>By the end of the course, students will acquire:</p> <p><b>Conceptual Understanding:</b> Explain fundamental principles, Describe the physics of relative phenomena, Connect physical principles to real-world phenomena in science and engineering contexts.</p> <p><b>Analytical and Mathematical Skills:</b> Apply calculus-based methods to analyze, Solve multi-step physics problems using algebra, trigonometry, derivatives, and integrals</p> <p><b>Problem-Solving Abilities:</b> Break down complex physical scenarios into solvable components, Evaluate the validity of assumptions, approximations, and results.</p>
<b>General Skills</b>	<p>By the end of the course, students will acquire:</p> <p><b>Communication Skills:</b> Communicate scientific reasoning and solutions clearly in written and oral formats.</p> <p><b>Application and Transfer of Knowledge:</b> Apply mechanics and wave principles to engineering systems, materials, and everyday physical situations, Use physics concepts to predict system behavior and evaluate engineering design choices, Demonstrate readiness for advanced courses on Materials' Engineering.</p>

3. COURSE CONTENT
<p>This course introduces the fundamental laws governing electric and magnetic fields, how they interact with matter, and how they combine to produce electromagnetic waves. Students learn how charges create electric fields, how currents produce magnetic fields, how changing fields generate induction, and how Maxwell's equations unify all of classical electromagnetism. The course builds strong physical intuition supported by calculus and vector analysis.</p>

4. LEARNING & TEACHING METHODS - EVALUATION					
<b>Teaching method</b>	Face-to-face.				
<b>Use of ICT</b>	<p>ICT plays a significant role in enhancing teaching, learning, experimentation, visualization, and assessment in this course as follows:</p> <p><b>Computational Tools for Problem Solving:</b> Spreadsheet calculations (Excel, Google Sheets), Coding solutions in Python, MATLAB, or Mathematica</p> <p><b>Online Learning Platforms:</b> Learning management systems (LMS) like Moodle, Online lectures, video tutorials, and animations,</p> <p><b>Communication and Collaboration:</b> Online discussion forums, Collaborative documents, Sharing of data and reports</p> <p><b>Presentation and Reporting Tools:</b> Lab reports (word processors), Data plots and charts (graphing tools), Presentations (PowerPoint, Google Slides).</p>				
<b>Teaching organization</b>	<p>The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).</p> <table border="1" data-bbox="523 2004 1337 2038"> <thead> <tr> <th>Activity</th> <th>Workload/semester (hours)</th> </tr> </thead> <tbody> <tr> <td> </td> <td> </td> </tr> </tbody> </table>	Activity	Workload/semester (hours)		
Activity	Workload/semester (hours)				

	Lectures	52
	self-study, quizzes, on-line tests	48
	Independent study	48
	Final written exam	2
	<b>Total</b>	<b>150</b>
<b>Student evaluation</b>	Assessment Language: English <ul style="list-style-type: none"> <li>Assessment Methods: Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Written Exams</li> </ul>	

## 5. SUGGESTED BIBLIOGRAPHY

### Course Bibliography

Principles & Practice of Physics | E. Mazur | (Volume 1) | ISBN 13: 978-0321949202 | Pearson 2014

### Additional bibliography for study

Principles & Practice of Physics | E. Mazur | (Volume 2) | ISBN: 978-0321957771 | Pearson 2014

## Mathematics II – Advanced Calculus

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	<b>MSEN 204</b>	<b>SEMESTER</b>	2 <sup>nd</sup> Semester
<b>COURSE TITLE</b>	<b>Mathematics II – Advanced Calculus</b>		
<b>TEACHING ACTIVITIES</b>	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>	
Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	4	6	
<b>COURSE TYPE</b>	This is a <b>core/compulsory engineering mathematics course</b> that provides advanced calculus tools, including multivariable calculus, vector calculus, differential equations, and numerical methods, with a strong focus on applications in materials engineering, such as heat transfer, diffusion, stress analysis, and material behavior modeling		
<b>PREREQUISITES</b>	Mathematics II builds on foundational calculus concepts covered in Mathematics I and introduces advanced tools required for modeling and analyzing complex engineering systems.		
<b>TEACHING AND EXAMINATION METHODS</b>	Lectures, Homework assignments, Quizzes (algebra, analytic geometry, differentiation), Midterm examination, Final exam		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes.		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	Students will be able to apply advanced calculus, vector calculus, and differential equations to model and analyze materials engineering systems. They will perform multivariable optimization, evaluate multiple integrals, solve ODEs and PDEs, use Laplace transforms, and apply numerical methods to solve engineering problems, interpreting mathematical results in the context of heat transfer, diffusion, stress analysis, and material behavior.
<b>General Skills</b>	By the end of the course, students will develop advanced problem-solving, analytical thinking, and quantitative reasoning skills, apply mathematical modeling to materials engineering problems, use computational tools effectively, and communicate mathematical results clearly in engineering contexts.

### 3. COURSE CONTENT

This course covers advanced calculus tools essential for analyzing and modeling materials engineering systems. Topics include higher-order derivatives, Taylor series, multivariable calculus, partial derivatives, optimization, multiple integrals, vector calculus, and key theorems such as Green's, Stokes', and Divergence Theorem. Students also study ordinary and partial differential equations, Laplace transforms, and basic numerical methods. Emphasis is placed on applications to heat transfer, diffusion, stress analysis, and other core materials engineering processes.

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face.												
<b>Use of ICT</b>	<p>ICT plays a significant role in enhancing teaching, learning, experimentation, visualization, and assessment in this course as follows:</p> <p><b>Computational Tools for Problem Solving:</b> Spreadsheet calculations (Excel, Google Sheets), Coding solutions in Python, MATLAB, or Mathematica</p> <p><b>Online Learning Platforms:</b> Learning management systems (LMS) like Moodle, Online lectures, video tutorials, and animations,</p> <p><b>Communication and Collaboration:</b> Online discussion forums, Collaborative documents, Sharing of data and reports</p> <p><b>Presentation and Reporting Tools:</b> Lab reports (word processors), Data plots and charts (graphing tools), Presentations (PowerPoint, Google Slides).</p>												
<b>Teaching organization</b>	<p>The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).</p> <table border="1"> <thead> <tr> <th>Activity</th> <th>Workload/semester (hours)</th> </tr> </thead> <tbody> <tr> <td>Lectures</td> <td>52</td> </tr> <tr> <td>self-study, quizzes, on-line tests</td> <td>46</td> </tr> <tr> <td>Independent study</td> <td>50</td> </tr> <tr> <td>Final written exam</td> <td>2</td> </tr> <tr> <td><b>Total</b></td> <td><b>150</b></td> </tr> </tbody> </table>	Activity	Workload/semester (hours)	Lectures	52	self-study, quizzes, on-line tests	46	Independent study	50	Final written exam	2	<b>Total</b>	<b>150</b>
Activity	Workload/semester (hours)												
Lectures	52												
self-study, quizzes, on-line tests	46												
Independent study	50												
Final written exam	2												
<b>Total</b>	<b>150</b>												
<b>Student evaluation</b>	<p>Assessment Language: English</p> <ul style="list-style-type: none"> <li>Assessment Methods: Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Written Exams</li> </ul>												

### 5. SUGGESTED BIBLIOGRAPHY

#### Course Bibliography

Mathematical Methods for Physics and Engineering: A Comprehensive Guide | ISBN: 978-0521679718 | Cambridge University Press, 2006

#### Additional bibliography for study

Advanced Engineering Mathematics | ISBN: 9781352010275 | Bloomsbury Publishing, 2020

## Bonding, Crystallography and Crystal Defects

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	<b>MSEN 205</b>	<b>SEMESTER</b>	2 <sup>nd</sup> Semester
<b>COURSE TITLE</b>	<b>Bonding, Crystallography and Crystal Defects</b>		
<b>TEACHING ACTIVITIES</b>	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>	
Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	4	6	
<b>COURSE TYPE</b>	<p>Students will develop:</p> <ul style="list-style-type: none"> <li>A foundational understanding of the fundamental aspects of the structure of matter needed for later courses relevant to the properties and processing of materials`.</li> <li>Familiarity with the basic instrumentation (x-ray diffractometers) used for the study of microstructure of materials</li> <li>Practicing the scientific method, evidence-based reasoning, and quantitative analysis, in realistic conditions.</li> </ul> <p>Students will be able to:</p> <ul style="list-style-type: none"> <li>Understand and apply the structure of matter (how atoms, molecules and clusters align in space, the interactions among them, the formation of crystals, and the basic crystallographic systems, the origin and manifestation of defects in crystalline materials).</li> <li>Demonstrate an understanding of experimental measurement of x-ray diffraction for the study of the structure of matter.</li> </ul>		
<b>PREREQUISITES</b>	No prerequisites		
<b>TEACHING AND EXAMINATION METHODS</b>	English		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes.		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p>Upon successful completion of this course, students will be able to:</p> <ul style="list-style-type: none"> <li>Describe the fundamental types of chemical bonding in solids (ionic, covalent, metallic, van der Waals, hydrogen bonding).</li> <li>Explain how bonding determines crystal stability, structure, and macroscopic properties.</li> <li>Identify, classify, and describe crystal structures using symmetry operations, crystal systems, Bravais lattices, point groups, and space groups.</li> </ul>

	<ul style="list-style-type: none"> <li>• Apply Miller indices, reciprocal lattice concepts, and Bragg's law to interpret diffraction patterns.</li> <li>• Understand the physical principles of X-ray, electron, and neutron diffraction.</li> <li>• Interpret real diffraction diagrams and extract structural parameters (unit cell, symmetry, interplanar distances).</li> <li>• Recognize, describe, and model crystal defects (point, line, and planar defects).</li> <li>• Evaluate the influence of defects on diffusion, conductivity, mechanical behavior, and materials performance.</li> </ul> <p>Use crystallographic software tools to visualize and analyze structures and defects</p>
<b>General Skills</b>	<p>Students will also acquire:</p> <ul style="list-style-type: none"> <li>• Search, analysis, and synthesis of data with ICT (Information and Communication Technologies)</li> <li>• Decision-making</li> <li>• Teamwork and interdisciplinary collaboration</li> <li>• Problem-solving and analytical thinking</li> <li>• Application of theoretical knowledge in laboratory settings</li> <li>• Respect for the natural environment</li> </ul>

### 3. COURSE CONTENT

Fundamental crystallographic concepts; Structure of crystals: lattice, basis, translational symmetry; Connection between crystallographic theory and X-ray techniques; Introduction to X-ray diffraction (XRD); Bragg's law and structure factor; Interaction of X-rays with matter; **Experimental Verification of Bragg's Law**; Structure–property relationships; **Crystal Defects: Point, Line and Planar defects**; Impact of defects on the properties of materials.

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face.						
<b>Use of ICT</b>	<p>ICT plays a significant role in enhancing teaching, learning, experimentation, visualization, and assessment in this course as follows:</p> <p><b>Computational Tools for Problem Solving:</b> Spreadsheet calculations (Excel, Google Sheets), Coding solutions in Python, MATLAB, or Mathematica</p> <p><b>Online Learning Platforms:</b> Learning management systems (LMS) like Moodle, Online lectures, video tutorials, and animations,</p> <p><b>Communication and Collaboration:</b> Online discussion forums, Collaborative documents, Sharing of data and reports</p> <p><b>Presentation and Reporting Tools:</b> Lab reports (word processors), Data plots and charts (graphing tools), Presentations (PowerPoint, Google Slides).</p>						
<b>Teaching organization</b>	<p>The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).</p> <table border="1"> <thead> <tr> <th>Activity</th> <th>Workload/semester (hours)</th> </tr> </thead> <tbody> <tr> <td>Lectures</td> <td>26</td> </tr> <tr> <td>Laboratory / Experimental Work</td> <td>24</td> </tr> </tbody> </table>	Activity	Workload/semester (hours)	Lectures	26	Laboratory / Experimental Work	24
Activity	Workload/semester (hours)						
Lectures	26						
Laboratory / Experimental Work	24						

	Written assignment / exercises	50
	<b>Total</b>	<b>150</b>
<b>Student evaluation</b>	<p>Assessment Language: English</p> <p>Methods of Assessment:</p> <ul style="list-style-type: none"> <li>• Final written exam (multiple choice, short answers, problem solving)</li> <li>• Problem-solving exercises</li> <li>• Laboratory or computational reports</li> <li>• Homework assignments</li> <li>• Optional presentations</li> <li>• Student Information:</li> </ul> <p>Detailed exam criteria and guidelines are posted on e-class</p> <ul style="list-style-type: none"> <li>• Sample exercises and past material provided online</li> </ul>	

## 5. SUGGESTED BIBLIOGRAPHY

### Course Bibliography

- Callister, *Materials Science and Engineering*
- Shackelford, *Introduction to Materials Science for Engineers*
- Askeland, *The Science and Engineering of Materials*

### Additional bibliography for study

- De Graef & McHenry, *Structure of Materials*
- Cullity, *Elements of X-Ray Diffraction*
- Kittel, *Introduction to Solid State Physics*

## 3<sup>rd</sup> Semester

### Physical Chemistry

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	<b>MSEN 301</b>	<b>SEMESTER</b>	3 <sup>rd</sup> Semester
<b>COURSE TITLE</b>	<b>Physical Chemistry</b>		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		4 (3L + 1T)	6
<b>COURSE TYPE</b>	Background / General knowledge / Scientific area		
<b>PREREQUISITES</b>	MSEN 102 Fundamentals of Chemistry		
<b>TEACHING AND EXAMINATION METHODS</b>	Face-to-face lectures and guided problem-solving sessions; short in-class quizzes; final written examination.		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes.		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p><b>Knowledge</b></p> <p>After successfully completing the course, students will be able to:</p> <ul style="list-style-type: none"> <li>• Explain the fundamental thermodynamic principles (energy, entropy, Gibbs free energy) governing the behavior of gases, liquids and solids.</li> <li>• Describe chemical and phase equilibria in multicomponent mixtures and analyze how temperature and pressure influence equilibrium.</li> <li>• Understand solution thermodynamics and electrolyte behavior, including ionic activity, colligative properties and the application of the Nernst equation.</li> <li>• Describe the fundamental principles of chemical kinetics and catalysis, with emphasis on reaction rates and mechanisms.</li> </ul> <p><b>Skills</b></p> <p>Upon completion, students will be able to:</p>

	<ul style="list-style-type: none"> <li>Apply thermodynamic, equilibrium and kinetic models to analyze the behavior and efficiency of elementary energy and environmental systems.</li> </ul> <p><b>Abilities / Competences</b></p> <p>Students will develop the ability to:</p> <ul style="list-style-type: none"> <li>Integrate thermodynamic, electrochemical and kinetic principles to interpret and predict the behavior of simple processes (e.g., electrolysis, catalytic reactions, gas-phase equilibria).</li> <li>Identify the physical-chemical factors (temperature, pressure, composition, phase changes, ionic strength)</li> </ul>
<b>General Skills</b>	<ul style="list-style-type: none"> <li>Problem solving with quantitative reasoning</li> <li>Teamwork</li> <li>Technical reporting and oral communication</li> <li>Searching, analyzing and synthesizing data and information</li> <li>Independent work</li> <li>Teamwork</li> <li>Promoting free, creative and inductive thinking</li> <li>Working in a multidisciplinary environment</li> </ul>

### 3. COURSE CONTENT

This course introduces the essential principles of Physical Chemistry. Core topics include the thermodynamic properties of gases, liquids and solids; the First, Second and Third Laws of Thermodynamics; and chemical and phase equilibria in multicomponent systems. Students explore the properties of solutions and electrolytes, ionic activity, and introductory electrochemistry. Fundamental concepts of chemical kinetics, chemical reactions and catalysis are also covered, focusing on reaction rates, temperature effects and mechanisms.

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face.
<b>Use of ICT</b>	<p>Use of ICT</p> <ul style="list-style-type: none"> <li>Use of ICT in Teaching</li> <li>Use of ICT in Communication with students</li> </ul> <p>Use of ICT – Description</p> <ul style="list-style-type: none"> <li>elearning.auth.gr: educational materials available to students along with exercises</li> <li>Teaching with electronic presentations (slides, video, etc.)</li> <li>Communication via elearning.aut.gr and emails</li> </ul>
<b>Teaching organization</b>	The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).

	Activity	Workload/semester (hours)	ECTS
	Lectures	39	1.56
	Tutorials / problem sessions	13	0.52
	Bibliographic Research and analysis	10	0.4
	Independent study	70	2.8
	Exam preparation	16	0.64
	Final written exam	2	0.08
	<b>Total</b>	<b>150</b>	<b>6</b>
<b>Student evaluation</b>	<p><b>Assessment language</b> The assessment language is English.</p> <p><b>Assessment methods</b> The course uses the following methods:</p> <ul style="list-style-type: none"> <li>• <b>Multiple choice tests:</b> three midterm exams to check recall of definitions, concepts, and terminology on core concepts of chemistry.</li> <li>• <b>Problem solving assignments:</b> three written assignments in which students review course material, analyze literature data, and solve problems on fundamentals of chemistry.</li> <li>• <b>Final written exam:</b> it combines short answers, problem solving, and data interpretation questions to evaluate cumulative understanding on core concepts of chemistry.</li> </ul> <p>Weighting</p> <ul style="list-style-type: none"> <li>• Multiple choice tests): 20%</li> <li>• Problem solving assignments: 20%</li> <li>• Final written exam: 60%</li> </ul> <p><b>Student information</b> Students are informed about the assessment process through:</p> <ul style="list-style-type: none"> <li>• The course outline distributed in the first lecture.</li> <li>• Detailed instructions for the written assignment and presentation posted on the course website.</li> <li>• A dedicated assessment briefing during tutoring time where expectations and criteria are explained.</li> </ul>		

## 5. SUGGESTED BIBLIOGRAPHY

### Course Bibliography

1. "Physical Chemistry", Peter Atkins, Julio de Paula, James Keeler, Oxford University Press, 2023
2. "Physical Chemistry for the Chemical Sciences", Raymond Chang, Jr. Thoman John W., University Science Books, 2014
3. "Physical Chemistry", David W. Ball, Cengage Learning, 2014

### Additional bibliography for study

- Teaching material slides

## Organic Chemistry Laboratory

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	<b>MSEN 302</b>	<b>SEMESTER</b>	2rd Semester
<b>COURSE TITLE</b>	<b>Organic Chemistry Laboratory</b>		
<b>TEACHING ACTIVITIES</b>	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>	
Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	Lectures: 1 Lab work: 3 Total: 4	6	
<b>COURSE TYPE</b>	Background and Scientific Area, Skill Development		
<b>PREREQUISITES</b>	No prerequisites		
<b>TEACHING AND EXAMINATION METHODS</b>	English		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p>By the end of this course, students will be able to:</p> <ul style="list-style-type: none"> <li>• Understand the concept of organic molecules, materials, their properties and synthesis</li> <li>• Design the synthesis and retrosynthesis of organic molecules as precursors of organic materials</li> <li>• Practice on common reactions for organic materials synthesis.</li> <li>• Practice on spectroscopy and chromatography for structure determination of organic compounds and materials.</li> </ul>
<b>General Skills</b>	<ul style="list-style-type: none"> <li>• Applying knowledge in practice</li> <li>• Searching, analyzing and synthesizing data and information, using the necessary spectroscopic and analytic technologies</li> <li>• Decision-making</li> <li>• Independent work</li> <li>• Teamwork</li> <li>• Generate new research ideas</li> <li>• Promoting free, creative and inductive thinking</li> </ul>

	<ul style="list-style-type: none"> <li>• Modeling and solving real-world problems</li> <li>• Working in a multidisciplinary environment</li> </ul>
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### 3. COURSE CONTENT

#### Laboratory exercises

1. Hydrolysis of methyl ester and isolation of benzoic acid with recrystallization technique.
2. Synthesis of benzoic methyl ester. Separation with acid/base extraction technique.
3. Photochemical synthesis of benzopinacol. Radical dimerization process.
4. Aldol Condensation for organic material synthesis: Synthesis of conjugated enones.
5. Pericyclic reactions. Synthesis of polyaromatic materials with cycloaddition reaction.
6. Characterization of organic precursors of materials using NMR spectroscopy.
7. Structure determination of organic materials: Combination of spectroscopy with chromatography.

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face.	
<b>Use of ICT</b>	Use of ICT in Course Teaching, Use of ICT in Laboratory Teaching, Use of ICT in Communication with Students Description: Use of Information and Communication Technologies (ICT) in teaching the course with tools of modern distance learning (ZOOM) and asynchronous education (eclass). Use of learning aids based on ICT: Excel, Word Use of ICT in student assessment: Electronic grading (eclass, universis). Use of ICT in communication with students: eclass, email, ZOOM.	
<b>Teaching organization</b>	The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).	
	<b>Activity</b>	<b>Workload/semester (hours)</b>
	Lectures	13
	Bibliographic written, research and problem solving	44
	Laboratory exercises	39
	Writing of Assignments	52
	Exams	2
	<b>Total</b>	<b>150</b>
<b>Student evaluation</b>	Assessment Language: English Assessment Methods: Written assignment, Problem Solving, Laboratory report, Written exams	

### 5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

«A Small-Scale Approach to Organic Laboratory Techniques» Ed. Donald L. Pavia, Gary M. Lampman, George S. Kriz, Randall G. Engel, 4<sup>th</sup> Edition, 2015, ISBN 130544602X, 9781305446021

**Additional bibliography for study**

- Teaching material slides

## Mathematics II – Advanced Calculus

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	<b>MSEN 303</b>	<b>SEMESTER</b>	3 <sup>rd</sup> Semester
<b>COURSE TITLE</b>	<b>Mathematics II – Advanced Calculus</b>		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		4	6
<b>COURSE TYPE</b>	This course introduces statistical methods and data analysis techniques essential for understanding, modeling, and interpreting experimental and industrial data in materials engineering. Emphasis is placed on practical applications, decision-making, and quality control in material processes.		
<b>PREREQUISITES</b>	Students are expected to have: Mathematics I & II – A solid foundation in algebra, calculus, and differential equations. Basic knowledge of materials engineering concepts – Understanding of material properties, mechanical behavior, and experimental methods. Familiarity with basic computing skills – Using spreadsheets or software for simple calculations and data handling.		
<b>TEACHING AND EXAMINATION METHODS</b>	Lectures, Homework assignments, Quizzes, Midterm examination, Final exam		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes.		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	Students will be able to apply advanced calculus, vector calculus, and differential equations to model and analyze materials engineering systems. They will perform multivariable optimization, evaluate multiple integrals, solve ODEs and PDEs, use Laplace transforms, and apply numerical methods to solve engineering problems, interpreting mathematical results in the context of heat transfer, diffusion, stress analysis, and material behavior.
<b>General Skills</b>	By the end of the course, students will develop advanced problem-solving, analytical thinking, and quantitative reasoning skills, apply mathematical modeling to materials engineering problems, use

	computational tools effectively, and communicate mathematical results clearly in engineering contexts.
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### 3. COURSE CONTENT

This course introduces statistical methods and data analysis techniques essential for materials engineering. Topics include descriptive statistics, probability, inferential statistics, correlation and regression, ANOVA, and statistical quality control. Emphasis is placed on applying these methods to analyze experimental data, predict material behavior, optimize processes, and support decision-making. Students also learn to use computational tools for data visualization, simulation, and statistical analysis.

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face.												
<b>Use of ICT</b>	<p>ICT plays a significant role in enhancing teaching, learning, experimentation, visualization, and assessment in this course as follows:</p> <p><b>Computational Tools for Problem Solving:</b> Spreadsheet calculations (Excel, Google Sheets), Coding solutions in Python, MATLAB, or Mathematica</p> <p><b>Online Learning Platforms:</b> Learning management systems (LMS) like Moodle, Online lectures, video tutorials, and animations,</p> <p><b>Communication and Collaboration:</b> Online discussion forums, Collaborative documents, Sharing of data and reports</p> <p><b>Presentation and Reporting Tools:</b> Lab reports (word processors), Data plots and charts (graphing tools), Presentations (PowerPoint, Google Slides).</p>												
<b>Teaching organization</b>	<p>The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 60%;">Activity</th> <th style="width: 40%;">Workload/semester (hours)</th> </tr> </thead> <tbody> <tr> <td>Lectures</td> <td style="text-align: center;">52</td> </tr> <tr> <td>self-study, quizzes, on-line tests</td> <td style="text-align: center;">46</td> </tr> <tr> <td>Independent study</td> <td style="text-align: center;">50</td> </tr> <tr> <td>Final written exam</td> <td style="text-align: center;">2</td> </tr> <tr> <td><b>Total</b></td> <td style="text-align: center;"><b>150</b></td> </tr> </tbody> </table>	Activity	Workload/semester (hours)	Lectures	52	self-study, quizzes, on-line tests	46	Independent study	50	Final written exam	2	<b>Total</b>	<b>150</b>
Activity	Workload/semester (hours)												
Lectures	52												
self-study, quizzes, on-line tests	46												
Independent study	50												
Final written exam	2												
<b>Total</b>	<b>150</b>												
<b>Student evaluation</b>	<p>Assessment Language: English</p> <ul style="list-style-type: none"> <li>Assessment Methods: Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Written Exams</li> </ul>												

### 5. SUGGESTED BIBLIOGRAPHY

#### Course Bibliography

Statistical Methods for Materials Science 1st Edition | ISBN 978-0367780289 | CRC Press, 2021

#### Additional bibliography for study

Materials Data Science | ISBN: 978-3-031-46564-2 | Springer 2024

## Thermodynamics

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	MSEN 304	<b>SEMESTER</b>	3rd Semester
<b>COURSE TITLE</b>	<b>Thermodynamics</b>		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		4 (3L + 1T)	6
<b>COURSE TYPE</b>	Scientific area / Skill development		
<b>PREREQUISITES</b>	General Chemistry; Calculus I–II; Introductory Physics. Recommended: Data Analysis/Statistics.		
<b>TEACHING AND EXAMINATION METHODS</b>	Face-to-face lectures and problem-solving tutorials. Continuous assessment via problem sets; final written examination.		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes (taught in English, subject to minimum enrollment).		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<ul style="list-style-type: none"> <li>• Apply the laws of thermodynamics and thermodynamic potentials to materials problems.</li> <li>• Use chemical potential and Gibbs free energy to analyze phase equilibria and phase diagrams.</li> <li>• Model ideal and non-ideal solutions using activities and mixing rules.</li> <li>• Analyze driving forces for phase transformations and chemical reactions in materials processing.</li> <li>• Perform basic calculations for multi-phase equilibrium using graphical and computational approaches.</li> <li>• Critically interpret thermodynamic data and assess assumptions/uncertainties.</li> </ul>
<b>General Skills</b>	<ul style="list-style-type: none"> <li>• Quantitative modeling and problem solving</li> <li>• Use of data and computational tools for engineering decisions</li> <li>• Independent learning from advanced references</li> <li>• Clear technical communication of assumptions and results</li> </ul>

### 3. COURSE CONTENT

- Thermodynamic variables, state functions, and the 1st and 2nd laws.
- Entropy, enthalpy, Helmholtz and Gibbs free energies; Maxwell relations.
- Chemical potential; phase equilibrium; phase rule; Clapeyron and Clausius–Clapeyron.
- Solution thermodynamics: ideal solutions, regular solutions, activities, partial molar quantities.
- Binary phase diagrams and common reactions (eutectic, peritectic, miscibility gaps).
- Thermodynamics of phase transformations and nucleation (driving force concepts).
- Thermochemistry and chemical reactions in materials (Ellingham-type analyses where relevant).
- Intro to statistical thermodynamics concepts relevant to materials.
- Introduction to computational thermodynamics (CALPHAD concept) and use of databases (overview / demos).

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face. Lectures combined with tutorial-based problem solving and guided computational demonstrations.																
<b>Use of ICT</b>	E-learning for notes/problem sets; spreadsheets/Python for equilibrium calculations; demonstrations of thermodynamic databases/software (where available).																
<b>Teaching organization</b>	The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards). <table border="1" data-bbox="523 1160 1339 1435"> <thead> <tr> <th>Activity</th> <th>Workload/semester (hours)</th> </tr> </thead> <tbody> <tr> <td>Lectures</td> <td>39</td> </tr> <tr> <td>Tutorials / problem sessions</td> <td>13</td> </tr> <tr> <td>Problem sets</td> <td>20</td> </tr> <tr> <td>Independent study</td> <td>60</td> </tr> <tr> <td>Exam preparation</td> <td>16</td> </tr> <tr> <td>Final written exam</td> <td>2</td> </tr> <tr> <td><b>Total</b></td> <td><b>150</b></td> </tr> </tbody> </table>	Activity	Workload/semester (hours)	Lectures	39	Tutorials / problem sessions	13	Problem sets	20	Independent study	60	Exam preparation	16	Final written exam	2	<b>Total</b>	<b>150</b>
Activity	Workload/semester (hours)																
Lectures	39																
Tutorials / problem sessions	13																
Problem sets	20																
Independent study	60																
Exam preparation	16																
Final written exam	2																
<b>Total</b>	<b>150</b>																
<b>Student evaluation</b>	Assessment language: English. Methods: written final exam (60%), graded problem sets (30%), short quiz or midterm test (10%). Students are informed via the course guide and e-learning announcements.																

### 5. SUGGESTED BIBLIOGRAPHY

#### EUDOXUS

To be specified in EUDOXUS.

#### Additional bibliography for study

- D.R. Gaskell, Introduction to the Thermodynamics of Materials.
- D.A. Porter, K.E. Easterling & M.Y. Sherif, Phase Transformations in Metals and Alloys (thermo sections).
- C. Kittel & H. Kroemer, Thermal Physics (selected chapters).
- Selected open courseware notes (indicative): MIT OCW Thermodynamics of Materials.

## Introduction to Solid Mechanics

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	<b>MSEN 305</b>	<b>SEMESTER</b>	3 <sup>rd</sup> Semester
<b>COURSE TITLE</b>	<b>Introduction to Solid Mechanics</b>		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		4 (3L + 1T)	6
<b>COURSE TYPE</b>	Background / General knowledge / Scientific area		
<b>PREREQUISITES</b>	None		
<b>TEACHING AND EXAMINATION METHODS</b>	Face-to-face lectures and guided problem-solving sessions; short in-class quizzes; final written examination.		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p>By the end of this course, students will be able to:</p> <ul style="list-style-type: none"> <li>• Construct and Utilize Free-Body Diagrams.</li> <li>• Analyze forces and moments in 3- and 2-Dimensional space</li> <li>• Understand support type in structures</li> <li>• Analyze Internal Forces in Structures.</li> <li>• Analyze properties of cross sections</li> </ul>
<b>General Skills</b>	<ul style="list-style-type: none"> <li>• Search for, analysis and synthesis of data and information, with the use of the necessary technology</li> <li>• Work autonomously</li> <li>• Advance free, creative and causative thinking</li> <li>• Adapting to new situations</li> <li>• Decision-making</li> <li>• Modeling and solving real-world problems</li> <li>• Working in a multidisciplinary environment</li> </ul>

3. COURSE CONTENT
<p>Description:</p> <p>This course is the foundation of engineering analysis, covering the principles of force systems on bodies. Focus on drawing Free-Body Diagrams, calculating Internal Forces (shear/moment) in structures.</p>

Key topics:

- Free Body Diagrams & Equilibrium: Modeling and balancing forces.
- Internal Forces: Axial/Shear force and bending moment calculations.
- Properties of cross-sections: Center of gravity and moments of inertia

#### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face. Lectures, guided problem sessions, short demonstrations, and small-group activities/case studies.																
<b>Use of ICT</b>	Use of ICT in Course Teaching, Use of ICT in Communication with Students Description: Use of Information and Communication Technologies (ICT) in teaching the course with tools of modern distance learning (MS-Teams) and asynchronous education (e-learning). Use of learning aids based on ICT: Excel Use of ICT in student assessment: Electronic grading (e-learning). Use of ICT in communication with students: e-learning, email, MS-Teams.																
<b>Teaching organization</b>	The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards). <table border="1" data-bbox="523 976 1337 1263"> <thead> <tr> <th>Activity</th> <th>Workload/semester (hours)</th> </tr> </thead> <tbody> <tr> <td>Lectures</td> <td>39</td> </tr> <tr> <td>Tutorials / problem sessions</td> <td>13</td> </tr> <tr> <td>Mid term evaluation</td> <td>20</td> </tr> <tr> <td>Independent study</td> <td>60</td> </tr> <tr> <td>Exam preparation</td> <td>16</td> </tr> <tr> <td>Final written exam</td> <td>2</td> </tr> <tr> <td><b>Total</b></td> <td><b>150</b></td> </tr> </tbody> </table>	Activity	Workload/semester (hours)	Lectures	39	Tutorials / problem sessions	13	Mid term evaluation	20	Independent study	60	Exam preparation	16	Final written exam	2	<b>Total</b>	<b>150</b>
Activity	Workload/semester (hours)																
Lectures	39																
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Mid term evaluation	20																
Independent study	60																
Exam preparation	16																
Final written exam	2																
<b>Total</b>	<b>150</b>																
<b>Student evaluation</b>	Assessment language: English. Written Exams with Problem Solving with Short Answer Written Exams with Problem Solving (Summative)																

#### 5. SUGGESTED BIBLIOGRAPHY

##### EUDOXUS

Beer, F. P., Johnston, E. R., Jr., Mazurek, D. F., & Cornwell, P. J. (2013). Vector mechanics for engineers: Statics (10th ed.). McGraw-Hill Education.

##### Additional bibliography for study

## 4<sup>th</sup> Semester

### Inorganic Materials Chemistry

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	<b>MSEN 401</b>	<b>SEMESTER</b>	4 <sup>th</sup> Semester
<b>COURSE TITLE</b>	<b>Inorganic Materials Chemistry</b>		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		4	6
<b>COURSE TYPE</b>	Background, General Knowledge		
<b>PREREQUISITES</b>	No prerequisites		
<b>TEACHING AND EXAMINATION METHODS</b>	English		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p>By the end of this course, students will be able to:</p> <ul style="list-style-type: none"> <li>• Understand and explain the structures of various types of inorganic materials (metals, ionic materials, molecular materials, and nanostructured materials).</li> <li>• Describe the factors that control the stability of inorganic materials.</li> <li>• Interpret electronic structure concepts in inorganic materials (band theory, conductivity, and semiconduction).</li> <li>• Summarize the range of synthesis routes for inorganic materials.</li> <li>• Understand the principles of major characterization tools of inorganic materials.</li> <li>• Connect structures to function for key classes of inorganic materials used in catalysis, energy storage, optics, semiconductors, and nanotechnology.</li> </ul> <p>By the end of this course, students will acquire skills to:</p>

	<ul style="list-style-type: none"> <li>• Describe crystal structures of inorganic materials.</li> <li>• Predict structure types of inorganic materials.</li> <li>• Evaluate band structures and relate them to conductivity and semiconducting behavior.</li> <li>• Choose suitable synthesis and characterization techniques for a given inorganic material.</li> <li>• Interpret experimental data from characterization methods of inorganic materials.</li> <li>• Assess how structural features influence ionic transport, catalytic activity, optical performance, and nanoscale behavior.</li> </ul> <p>By the end of the course, students will be able to:</p> <ul style="list-style-type: none"> <li>• Propose synthesis and characterization strategies for specific inorganic materials.</li> <li>• Critically judge structure property relationships in advanced solids, including nanostructures and porous frameworks.</li> <li>• Apply foundational concepts to emerging materials for energy, electronics, catalysis, and storage.</li> <li>• Communicate materials chemistry concepts clearly in written and oral formats.</li> </ul>
<p><b>General Skills</b></p>	<p>By the end of this course, students will be able to: Upon successful completion of the course, students will strengthen their:</p> <ul style="list-style-type: none"> <li>• Analytical thinking and quantitative reasoning.</li> <li>• Problem solving using chemical principles applied to inorganic real materials.</li> <li>• Ability to connect theory with practical characterization data.</li> <li>• Scientific communication skills, both written and spoken.</li> <li>• Ability to work with structured information such as diagrams, models, and datasets.</li> <li>• Capacity to engage in self-directed learning and literature exploration.</li> </ul>

### 3. COURSE CONTENT

#### Part 1 – Structures of inorganic materials

- Description of the structures of inorganic materials - Unit cells and the description of crystal structures; Symmetry in crystal structures; The close packing of spheres; Holes in close-packed structures.
- The structures of metals and alloys - Polytypism; Nonclose-packed structures; Polymorphism of metals; Atomic radii of metals; Alloys and interstitials.
- The structures of ionic materials - The rationalization of structures; The

energetics of ionic bonding; Lattice enthalpy and the Born-Haber cycle; The calculation of lattice enthalpies; Comparison of experimental and theoretical values; The Kapustinskii equation; Consequences of lattice enthalpies.

- Defects and nonstoichiometry - The origins and types of defects; Nonstoichiometric compounds and solid solutions.

**Part 2 – Electronic structures of inorganic materials**

- The conductivities of inorganic solids; Band theory in inorganic solids; Semiconduction.

**Part 3 – Synthesis and characterization of inorganic materials**

- Synthesis of inorganic materials - Direct synthesis at high temperatures; Solution methods.
- Physical methods for characterizing inorganic materials – Diffraction methods; Absorption and emission spectroscopies; Ionization-based techniques; Chemical analysis; Magnetometry and magnetic susceptibility; Electrochemical techniques; Microscopy

**Part 4 – Key classes of inorganic materials**

- Defects and ion transport - Extended defects; Atom and ion diffusion; Solid electrolytes.
- Metal oxides, nitrides, and fluorides: Monoxides of the 3d metals; Higher oxides and complex oxides; Oxide glasses; Nitrides, fluorides, and mixed-anion phases.
- Sulfides, intercalation compounds, and metal-rich phases - Layered  $MS_2$  compounds and intercalation; Chevrel phases and chalcogenide thermoelectrics.
- Framework structures and heterogeneous catalysis in porous materials - Structures based on tetrahedral oxoanions; Structures based on linked octahedral and tetrahedral centres; Zeolites and microporous structures in heterogeneous catalysis.
- Hydrides and hydrogen-storage materials - Metal hydrides; Other inorganic hydrogen-storage materials.
- Optical properties of inorganic materials - Colored solids; White and black pigments; Photocatalysts.
- Semiconductor chemistry - Group 14 semiconductors; Semiconductor systems isoelectronic with silicon.
- Molecular materials - Molecular materials chemistry.
- Nanomaterials - Synthesis and characterization of nanomaterials.
- Nanostructures and properties - One-dimensional: carbon nanotubes and inorganic nanowires; Two-dimensional: graphene, quantum wells, and solid-state superlattices; Three-dimensional: mesoporous materials and composites; Special optical properties of nanomaterials.

Heterogeneous nanoparticle catalysts - The nature of heterogeneous catalysts; Reactions involving heterogeneous nanoparticle catalysts

**4. LEARNING & TEACHING METHODS - EVALUATION**

<b>Teaching method</b>	Face-to-face.
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<b>Use of ICT</b>	<p>ICT will be used in teaching the course, and in communication with students:</p> <ul style="list-style-type: none"> <li>teaching of the course with modern distance learning (ZOOM) and asynchronous education tools via elearning platform of AUTH,</li> </ul> <p>communication with students via email, ZOOM, and elearning platform of AUTH.</p>														
<b>Teaching organization</b>	<p>The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).</p> <table border="1" data-bbox="528 573 1337 862"> <thead> <tr> <th>Activity</th> <th>Workload/semester (hours)</th> </tr> </thead> <tbody> <tr> <td>Lectures</td> <td>52</td> </tr> <tr> <td>Bibliographic written, research and problem solving</td> <td>32</td> </tr> <tr> <td>Tutorial</td> <td>32</td> </tr> <tr> <td>Written assignments</td> <td>32</td> </tr> <tr> <td>Exams</td> <td>2</td> </tr> <tr> <td><b>Total</b></td> <td><b>150</b></td> </tr> </tbody> </table>	Activity	Workload/semester (hours)	Lectures	52	Bibliographic written, research and problem solving	32	Tutorial	32	Written assignments	32	Exams	2	<b>Total</b>	<b>150</b>
Activity	Workload/semester (hours)														
Lectures	52														
Bibliographic written, research and problem solving	32														
Tutorial	32														
Written assignments	32														
Exams	2														
<b>Total</b>	<b>150</b>														
<b>Student evaluation</b>	<p><b>Assessment language</b> The assessment language is English.</p> <p><b>Assessment methods</b> The course uses the following methods:</p> <ul style="list-style-type: none"> <li><b>Multiple choice tests:</b> two midterm exams to check recall of definitions, concepts, and terminology on core concepts on inorganic materials.</li> <li><b>Problem solving assignments:</b> two written assignments in which students review course material, analyze literature data, and solve problems on inorganic materials.</li> <li><b>Final written exam:</b> it combines short answers, problem solving, and data interpretation questions to evaluate cumulative understanding on core concepts of inorganic materials.</li> </ul> <p><b>Weighting</b></p> <ul style="list-style-type: none"> <li>Multiple choice tests): 20%</li> <li>Problem solving assignments: 20%</li> <li>Final written exam: 60%</li> </ul> <p><b>Student information</b> Students are informed about the assessment process through:</p> <ul style="list-style-type: none"> <li>The course outline distributed in the first lecture.</li> <li>Detailed instructions for the written assignment and presentation posted on the course website.</li> <li>A dedicated assessment briefing during tutoring time where expectations and criteria are explained.</li> </ul>														
<b>5. SUGGESTED BIBLIOGRAPHY</b>															
<b>EUDOXUS</b>															
M.T. Weller, J. Rourke, F.A. Armstrong, S. Lancaster, T. Overton, Inorganic chemistry. 8th edn. Oxford University Press (2025)															

E.A. Moore and L.E. Smart, Solid state chemistry: an introduction. 5th ed. CRC Press (2020).

A.R. West, Solid state chemistry and its applications, 2nd edn. John Wiley & Sons (2014).

M.T. Weller, Inorganic materials chemistry. Oxford Chemistry Primers 23. Oxford University Press (1994).

**Additional bibliography for study**

- Teaching material slides

## Physical Chemistry Laboratory

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	<b>MSEN 402</b>	<b>SEMESTER</b>	4 <sup>th</sup> Semester
<b>COURSE TITLE</b>	<b>Physical Chemistry Laboratory</b>		
<b>TEACHING ACTIVITIES</b>	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>	
Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	Lectures: 1 Lab work: 3 Total: 4	6	
<b>COURSE TYPE</b>	Background, General Knowledge		
<b>PREREQUISITES</b>	No prerequisites		
<b>TEACHING AND EXAMINATION METHODS</b>	English		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	The goal of the Physical Chemistry Laboratory, through its operation and the training it provides to students on selected and representative laboratory exercises, is on the one hand to support the course of Physical Chemistry with an in-depth understanding of the basic principles and laws, on the other hand and the familiarization and reconciliation of the student with the laboratory environment. These exercises are internationally and widely accepted and wellknown over time and are taught in the four semester of studies in the Departments of Materials Science as well as (several of them) in the Department of Chemistry (Department of Chemistry) of our University. The aim is also to develop the reflection and practice of the student to think in the language of Science, to observe and not to see, to interpret the phenomena and not to memorize theories. The aim is to develop his research disposition, his training in the correct presentation and processing of experimental results as well as in the protection and safe use of laboratory equipment. The form and content of these laboratory exercises have been organized based on the experience in the

	<p>student laboratories and the evaluation of the current and future direction of the field of Physical Chemistry of the materials.</p> <p>Upon successful completion of the course the student will be able to:</p> <ul style="list-style-type: none"> <li>• form the composition of the working group in order to achieve the maximum result.</li> <li>• work in a team with a spirit of cooperation and creative coexistence.</li> <li>• Handle and use the capabilities of the programs: ORIGIN, EXCEL, ChemOffice, ChemDraw, etc.</li> <li>• look for the relevant literature which becomes necessary for the comparison and confirmation of his experimental results.</li> <li>• Understand differently and in depth the concepts of physicochemistry that are established through laboratory practice.</li> </ul> <p>judge, to compare and interpret phenomena.</p>
<b>General Skills</b>	<ul style="list-style-type: none"> <li>• Applying knowledge in practice</li> <li>• Searching, analyzing and synthesizing data and information</li> <li>• Independent work</li> <li>• Teamwork</li> <li>• Promoting free, creative and inductive thinking</li> <li>• Solving real-world problems</li> <li>• Working in a multidisciplinary environment</li> </ul>

### 3. COURSE CONTENT

Laboratory experiments introduce key experimental techniques for the characterization of physical and chemical behavior, covering the following areas:

- Calorimetry
- Boiling Points. Mixing Points Distribution
- Electrolytic conductivity solutions
- pH metry determination pK acids
- The effect of temperature and ionic strength on reaction rate.

Conductometric, spectrophotometric and polosimetric monitoring of reaction kinetics.

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face.
<b>Use of ICT</b>	<p>ICT will be used in teaching the course, and in communication with students:</p> <ul style="list-style-type: none"> <li>• teaching of the course with modern distance learning (ZOOM) and asynchronous education tools via elearning platform of AUTH,</li> <li>• communication with students via email, ZOOM, and elearning platform of AUTH.</li> </ul>

<b>Teaching organization</b>	The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).	
	<b>Activity</b>	<b>Workload/semester (hours)</b>
	Lectures	13
	Bibliographic written, research and problem solving	55
	Laboratory exercises	39
	Written assignments	41
	Exams	2
<b>Total</b>	<b>150</b>	
<b>Student evaluation</b>	Assessment Language: English Assessment Methods: <ul style="list-style-type: none"> <li>• Written assignment</li> <li>• Problem Solving</li> <li>• Laboratory report</li> <li>• Written exams</li> </ul>	
<b>5. SUGGESTED BIBLIOGRAPHY</b>		
<b>EUDOXUS</b>		
"Physical Chemistry", Peter Atkins, Julio de Paula, James Keeler, Oxford University Press, 2023 "Physical Chemistry for the Chemical Sciences", Raymond Chang, Jr. Thoman John W., University Science Books, 2014 "Physical Chemistry", David W. Ball, Cengage Learning, 2014		
<b>Additional bibliography for study</b>		
Teaching material slides		

## Design and analysis of materials experiments

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	<b>MSEN 403</b>	<b>SEMESTER</b>	4 <sup>th</sup> Semester
<b>COURSE TITLE</b>	<b>Design and analysis of materials experiments</b>		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		4 (3L + 1T)	6
<b>COURSE TYPE</b>	Mandatory / Scientific area / Skills development		
<b>PREREQUISITES</b>	None		
<b>TEACHING AND EXAMINATION METHODS</b>	Face-to-face lectures and guided problem-solving sessions; short in-class quizzes; final written examination.		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p>By the end of this course, students will be able to:</p> <ul style="list-style-type: none"> <li>• Plan robust experimental processes.</li> <li>• Analyze forces and moments in 3- and 2-Dimensional space</li> <li>• Evaluate the statistical validity of experimental conclusions</li> </ul>
<b>General Skills</b>	<ul style="list-style-type: none"> <li>• Search for, analysis and synthesis of data and information, with the use of the necessary technology</li> <li>• Work autonomously</li> <li>• Advance free, creative and causative thinking</li> <li>• Adapting to new situations</li> <li>• Decision-making</li> <li>• Modeling and solving real-world problems</li> <li>• Working in a multidisciplinary environment</li> </ul>

3. COURSE CONTENT
<p>Description:</p> <p>This course bridges the gap between material characterization and statistical decision-making. Students will move beyond "trial-and-error" approaches, learning to systematically vary</p>

multiple processing parameters simultaneously. The curriculum focuses on identifying critical factors that influence material performance and optimizing processes to achieve superior material properties.

Key topics:

- Fundamentals of Statistics in Materials.
- Analysis of Variance (ANOVA).
- Process Optimization
- Experimental processes planning and execution

#### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face. Lectures, guided problem sessions, short demonstrations, and small-group activities/case studies.																
<b>Use of ICT</b>	Use of ICT in Course Teaching, Use of ICT in Communication with Students Description: Use of Information and Communication Technologies (ICT) in teaching the course with tools of modern distance learning (MS-Teams) and asynchronous education (e-learning). Use of learning aids based on ICT: Excel Use of ICT in student assessment: Electronic grading (e-learning). Use of ICT in communication with students: e-learning, email, MS-Teams.																
<b>Teaching organization</b>	The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards). <table border="1" data-bbox="523 1146 1337 1435"> <thead> <tr> <th>Activity</th> <th>Workload/semester (hours)</th> </tr> </thead> <tbody> <tr> <td>Lectures</td> <td>39</td> </tr> <tr> <td>Tutorials / problem sessions</td> <td>13</td> </tr> <tr> <td>Mid term evaluation</td> <td>20</td> </tr> <tr> <td>Independent study</td> <td>60</td> </tr> <tr> <td>Exam preparation</td> <td>16</td> </tr> <tr> <td>Final written exam</td> <td>2</td> </tr> <tr> <td><b>Total</b></td> <td><b>150</b></td> </tr> </tbody> </table>	Activity	Workload/semester (hours)	Lectures	39	Tutorials / problem sessions	13	Mid term evaluation	20	Independent study	60	Exam preparation	16	Final written exam	2	<b>Total</b>	<b>150</b>
Activity	Workload/semester (hours)																
Lectures	39																
Tutorials / problem sessions	13																
Mid term evaluation	20																
Independent study	60																
Exam preparation	16																
Final written exam	2																
<b>Total</b>	<b>150</b>																
<b>Student evaluation</b>	Assessment language: English. Written Exams with Problem Solving with Short Answer Written Exams with Problem Solving (Summative)																

#### 5. SUGGESTED BIBLIOGRAPHY

##### EUDOXUS

Montgomery, D. C. (2017). Vector mechanics for engineers: Statics (9th ed.). John Wiley & Sons, Inc.

##### Additional bibliography for study

## Condensed Mater Physics

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	<b>MSEN 404</b>	<b>SEMESTER</b>	4 <sup>th</sup> Semester
<b>COURSE TITLE</b>	<b>Condensed Mater Physics</b>		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		4	6
<b>COURSE TYPE</b>	This course introduces the principles of condensed matter physics with a focus on applications in materials engineering. It covers the structure, properties, and behavior of solids, linking microscopic theories to macroscopic material properties. The course emphasizes understanding crystalline structures, electronic behavior, thermal and mechanical properties, and modern materials applications.		
<b>PREREQUISITES</b>	Students should have a solid foundation in general physics, calculus, linear algebra, basic materials science, and chemistry. Familiarity with data analysis and graphing tools is also recommended to support understanding of experimental results and material behavior.		
<b>TEACHING AND EXAMINATION METHODS</b>	Lectures, Homework assignments, Quizzes, Midterm examination, Final exam		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes.		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p>Students completing this course will be able to:</p> <ul style="list-style-type: none"> <li>• Understand and describe crystal structures and lattice defects.</li> <li>• Apply diffraction and characterization techniques to analyze materials.</li> <li>• Explain electronic, thermal, optical, and magnetic properties of solids.</li> <li>• Relate microscopic theories to macroscopic material behavior.</li> <li>• Analyze material properties for engineering applications.</li> </ul>
<b>General Skills</b>	<p>Students will develop analytical and problem-solving skills, interpret and apply mathematical and physical models, analyze experimental data, and use computational tools to support materials engineering applications. They will also gain the ability to communicate scientific results clearly and effectively..</p>

### 3. COURSE CONTENT

This course covers the physical principles underlying the structure and properties of solids, including crystal structures, lattice vibrations, electronic, thermal, optical, and magnetic properties. Students will learn characterization techniques such as X-ray diffraction, explore superconductivity and modern nanomaterials, and apply these concepts to understand and engineer material behavior in practical applications.

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face.												
<b>Use of ICT</b>	<p>ICT plays a significant role in enhancing teaching, learning, experimentation, visualization, and assessment in this course as follows:</p> <p><b>Computational Tools for Problem Solving:</b> Spreadsheet calculations (Excel, Google Sheets), Coding solutions in Python, MATLAB, or Mathematica</p> <p><b>Online Learning Platforms:</b> Learning management systems (LMS) like Moodle, Online lectures, video tutorials, and animations,</p> <p><b>Communication and Collaboration:</b> Online discussion forums, Collaborative documents, Sharing of data and reports</p> <p><b>Presentation and Reporting Tools:</b> Lab reports (word processors), Data plots and charts (graphing tools), Presentations (PowerPoint, Google Slides).</p>												
<b>Teaching organization</b>	<p>The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).</p> <table border="1" data-bbox="523 1122 1337 1346"> <thead> <tr> <th>Activity</th> <th>Workload/semester (hours)</th> </tr> </thead> <tbody> <tr> <td>Lectures</td> <td>52</td> </tr> <tr> <td>self-study, quizzes, on-line tests</td> <td>46</td> </tr> <tr> <td>Independent study</td> <td>50</td> </tr> <tr> <td>Final written exam</td> <td>2</td> </tr> <tr> <td><b>Total</b></td> <td><b>150</b></td> </tr> </tbody> </table>	Activity	Workload/semester (hours)	Lectures	52	self-study, quizzes, on-line tests	46	Independent study	50	Final written exam	2	<b>Total</b>	<b>150</b>
Activity	Workload/semester (hours)												
Lectures	52												
self-study, quizzes, on-line tests	46												
Independent study	50												
Final written exam	2												
<b>Total</b>	<b>150</b>												
<b>Student evaluation</b>	<p>Assessment Language: English</p> <ul style="list-style-type: none"> <li>Assessment Methods: Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Written Exams</li> </ul>												

### 5. SUGGESTED BIBLIOGRAPHY

#### Course Bibliography

Fundamentals of Condensed Matter and Crystalline Physics | ISBN 9781139062077 | Cambridge University Press, 2012

#### Additional bibliography for study

Fundamentals of Condensed Matter Physics | ISBN 9780521513319 | Cambridge University Press 2016

## Polymer Science and Engineering: Theory and Laboratory

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	<b>MSEN 405</b>	<b>SEMESTER</b>	4 <sup>th</sup> Semester
<b>COURSE TITLE</b>	<b>Polymer Science and Engineering: Theory and Laboratory</b>		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		4	6
<b>COURSE TYPE</b>	Scientific Area		
<b>PREREQUISITES</b>	No prerequisites		
<b>TEACHING AND EXAMINATION METHODS</b>	English		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p>By the end of this course, students will be able to:</p> <ol style="list-style-type: none"> <li>1. understand the concept of macromolecule and the characteristic properties that macromolecules have in relation to small molecules.</li> <li>2. recognize the repeating chemical structural unit of several polymers.</li> <li>3. understand the mechanisms of both chain radical and step polymerization reactions</li> <li>4. develop equations describing the kinetics of both chain-radical and step polymerization</li> <li>5. realize the properties of different commercial polymers.</li> <li>6. understand the characteristics of the copolymerization reactions and the equations describing the copolymer composition.</li> <li>7. carry out simple laboratory syntheses of polymers</li> <li>8. determine the basic properties of different polymers</li> <li>9. know the recycling methods of different polymers</li> </ol> <p>solve specific problems related to the kinetics of polymerization reactions.</p>
<b>General Skills</b>	<ul style="list-style-type: none"> <li>• Applying knowledge in practice</li> <li>• Searching, analyzing and synthesizing data and information, using the necessary technologies</li> </ul>

	<ul style="list-style-type: none"> <li>• Decision-making</li> <li>• Independent work</li> <li>• Teamwork</li> <li>• Generate new research ideas</li> <li>• Project planning and management emphasizing on the materials science</li> <li>• Promoting free, creative and inductive thinking</li> <li>• Modeling and solving real-world problems</li> <li>• Working in a multidisciplinary environment</li> </ul>
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### 3. COURSE CONTENT

#### 1. Introduction to Polymer Science and Engineering

- The concept of macromolecule.
- Classification and nomenclature of polymers.
- Structure and dimensions of macromolecular chains.

#### Polymer synthesis

#### 2. Polymerization reactions

- Similarities and differences of various polymerization reactions

#### 3. Free radical chain polymerization

- Mechanism of the reaction.
- Polymerization kinetics.
- Initiators, monomers, retardants, inhibitors.
- Calculation of average molecular weight and molecular weight distribution of a polymer.
- Effect of diffusion phenomena on the polymerization reaction.

#### 4. Controlled radical polymerization

- Chain anionic, cationic and stereoregular polymerization.
- Mechanisms of reactions.
- Atom transfer radical polymerization.
- Nitroxide mediated polymerization.
- RAFT polymerization

#### 5. Step polymerization

- Mechanism of the reaction.
- Kinetics of step polymerization.
- Molecular weight distribution.
- Linear and crosslinked polymers.

#### 6. Typical polymers

- Polyethylenes, polypropylene, polystyrene, polyisoprene, poly(vinyl chloride), polytetrafluoroethylene, poly(methyl methacrylate), poly(vinyl acetate), polyethers, Polyesters (poly(ethylene terephthalate), polyamides (Nylons), polyurethanes, resins.

#### 7. Copolymerization

- Copolymer composition
- Reactivity ratios
- Types of copolymers
- Reaction kinetics

#### Properties of polymers

8. Molecular Weight distribution and Average molecular weights <ul style="list-style-type: none"> <li>Equations for the estimation of the molecular weight distribution and average molecular weights of polymers.</li> <li>Experimental techniques for determining average molecular weights and the entire Molecular Weight Distribution of polymers</li> </ul>
9. Solid state of polymers <ul style="list-style-type: none"> <li>Amorphous and crystalline state.</li> <li>Kinetics of crystallization.</li> <li>Glass transition temperature of polymers.</li> </ul>
Polymer Engineering
10. Polymer reaction engineering <ul style="list-style-type: none"> <li>Modeling of chain polymerization.</li> <li>Models for the step polymerization.</li> <li>Statistical methods for the estimation of the average molecular weights (method of moments).</li> <li>Equations for the estimation of the full molecular weight distribution.</li> </ul>
11. Polymer process engineering <ul style="list-style-type: none"> <li>Viscoelastic properties.</li> <li>Viscosity models for polymers.</li> <li>Non-Newtonian flow.</li> <li>Introduction to polymer rheology.</li> </ul>
12. Polymers and the environment <ul style="list-style-type: none"> <li>Polymer recycling.</li> <li>Chemical/thermo-chemical/physical recycling.</li> <li>Recycling of multilayer polymer films or polymer composites.</li> <li>Microplastics.</li> <li>Hazardous substances in polymeric products</li> </ul>
Laboratory exercises <ol style="list-style-type: none"> <li>Synthesis of polymers (e.g. poly(methyl methacrylate), elastomer)</li> <li>Characterization of polymers (e.g. measurement of average molecular weight of polymers, characterization of polymer fibers)</li> </ol>

4. LEARNING & TEACHING METHODS - EVALUATION					
Teaching method	Face-to-face.				
Use of ICT	ICT will be used in teaching the course, and in communication with students: <ul style="list-style-type: none"> <li>teaching of the course with modern distance learning (ZOOM) and asynchronous education tools via elearning platform of AUTH,</li> </ul> communication with students via email, ZOOM, and elearning platform of AUTH.				
Teaching organization	The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards). <table border="1" data-bbox="523 1962 1337 2033"> <thead> <tr> <th>Activity</th> <th>Workload/semester (hours)</th> </tr> </thead> <tbody> <tr> <td>Lectures</td> <td>27</td> </tr> </tbody> </table>	Activity	Workload/semester (hours)	Lectures	27
Activity	Workload/semester (hours)				
Lectures	27				

	Bibliographic written, research and problem solving	52
	Tutorial	9
	Laboratory exercises	16
	Written assignments	44
	Exams	2
	<b>Total</b>	<b>150</b>
<b>Student evaluation</b>	Assessment Language: English Assessment Methods: <ul style="list-style-type: none"> <li>• Written assignment</li> <li>• Problem Solving</li> <li>• Presentation in audience</li> <li>• Laboratory report</li> </ul>	
<b>5. SUGGESTED BIBLIOGRAPHY</b>		
<b>EUDOXUS</b>		
-		
<b>Additional bibliography for study</b>		
Billmeyer, F.W. Jr. (1984). Textbook of Polymer Science. 3rd Ed. New York: J. Wiley Davis, T.P., & Matyjaszewski, K. (2002). Handbook of Radical Polymerization. Hoboken: Wiley-Interscience. Fried, J.R. (2003). Polymer Science and Technology. USA: Prentice Hall. Manas, C. (2006). Introduction to Polymer Science and Chemistry. Florida: CRC, Taylor & Francis Group Odian, G. (2004). Principles of Polymerization. 4th Ed. Wiley-Interscience, Hoboken. Saldivar-Guerra, E., & Vivaldo-Lima, E. (2013) Eds. Handbook of polymer synthesis, characterization and processing, J. Wiley & Sons. Hoboken.		

## 5<sup>th</sup> Semester

### Inorganic Materials Chemistry Laboratory

1. GENERAL			
SCHOOL	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
DEPARTMENT	Materials Science and Engineering		
LEVEL OF STUDIES	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
COURSE CODE	MSEN 501	SEMESTER	5 <sup>th</sup> Semester
COURSE TITLE	Inorganic Materials Chemistry Laboratory		
TEACHING ACTIVITIES	LECTURES PER WEEK	ECTS CREDITS	
Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.			
	Lectures: 1 Lab work: 3 Total: 4	6	
COURSE TYPE	Background, General Knowledge		
PREREQUISITES	No prerequisites		
TEACHING AND EXAMINATION METHODS	English		
COURSE OFFERED TO ERASMUS STUDENTS	Yes		
COURSE URL	<a href="https://elearning.auth.gr/course/view.php?id=xxxx">https://elearning.auth.gr/course/view.php?id=xxxx</a>		

2. LEARNING OUTCOMES	
Learning Outcomes	<p>By the end of this course, students will be able to:</p> <ul style="list-style-type: none"> <li>• Perform solid-state reactions involving inorganic precursors and explain the role of diffusion, temperature, and stoichiometry.</li> <li>• Carry out sol-gel and coprecipitation syntheses and describe how reaction conditions influence particle size and morphology.</li> <li>• Synthesize metal-organic frameworks (MOFs) via solution or solvothermal methods and explain self-assembly in coordination solids.</li> <li>• Incorporate dopants into inorganic host lattices and predict their effects on material properties.</li> <li>• Apply post-synthetic treatments such as calcination, activation, or solvent exchange.</li> </ul>
General Skills	By the end of this course, students will be able to:

	<ul style="list-style-type: none"> <li>• Explain the fundamental principles governing the synthesis, structure, and properties of inorganic materials.</li> <li>• Compare solid-state, solution-based, and solvothermal synthesis routes and justify the selection of a method for a given material.</li> <li>• Correlate composition, crystal structure, defects, and microstructure with physical properties of inorganic solids.</li> <li>• Safely conduct high-temperature, solution-phase, and materials-processing experiments following best laboratory practices.</li> <li>• Analyze experimental data using appropriate chemical, physical, and crystallographic models.</li> <li>• Communicate scientific results clearly in written reports and oral or poster-style presentations.</li> </ul>
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### 3. COURSE CONTENT

Laboratory experiments covering the following areas:

- Solid state synthesis and characterization of materials such as spinel oxides
- Sol-gel synthesis and characterization of metal oxide nanoparticles
- Preparation and photophysical characterization of doped phosphor materials
- Solvothermal synthesis and characterization of metal-organic frameworks (MOFs)
- Fabrication and testing of a conducting oxide material
- Fabrication and testing of a dye-sensitized solar cell (DSSC)

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face.	
<b>Use of ICT</b>	ICT will be used in teaching the course, and in communication with students: <ul style="list-style-type: none"> <li>• teaching of the course with modern distance learning (ZOOM) and asynchronous education tools via elearning platform of AUTH,</li> <li>• communication with students via email, ZOOM, and elearning platform of AUTH.</li> </ul>	
<b>Teaching organization</b>	The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).	
	<b>Activity</b>	<b>Workload/semester (hours)</b>
	Lectures	13
	Bibliographic written, research and problem solving	40
	Laboratory exercises	39
	Writing of Assignments	56
	Exams	2
<b>Total</b>	<b>150</b>	
<b>Student evaluation</b>	<b>Assessment language</b>	

	<p>The assessment language is English.</p> <p><b>Assessment methods</b></p> <p>The course uses the following methods:</p> <ul style="list-style-type: none"> <li>• <b>Multiple choice tests:</b> two midterm exams to check recall of definitions, concepts, and terminology on core concepts on inorganic materials.</li> <li>• <b>Problem solving assignments:</b> two written assignments in which students review course material, analyze literature data, and solve problems on inorganic materials.</li> <li>• <b>Final written exam:</b> it combines short answers, problem solving, and data interpretation questions to evaluate cumulative understanding on core concepts of inorganic materials.</li> </ul> <p>Weighting</p> <ul style="list-style-type: none"> <li>• Multiple choice tests): 20%</li> <li>• Problem solving assignments: 20%</li> <li>• Final written exam: 60%</li> </ul> <p><b>Student information</b></p> <p>Students are informed about the assessment process through:</p> <ul style="list-style-type: none"> <li>• The course outline distributed in the first lecture.</li> <li>• Detailed instructions for the written assignment and presentation posted on the course website.</li> <li>• A dedicated assessment briefing during tutoring time where expectations and criteria are explained.</li> <li>•</li> </ul>
<b>5. SUGGESTED BIBLIOGRAPHY</b>	
<b>EUDOXUS</b>	
<p>M.T. Weller, J. Rourke, F.A. Armstrong, S. Lancaster, T. Overton, Inorganic chemistry. 8th edn. Oxford University Press (2025)</p> <p>E.A. Moore and L.E. Smart, Solid state chemistry: an introduction. 5th ed. CRC Press (2020).</p> <p>A.R. West, Solid state chemistry and its applications, 2nd edn. John Wiley &amp; Sons (2014).</p> <p>M.T. Weller, Inorganic materials chemistry. Oxford Chemistry Primers 23. Oxford University Press (1994).</p>	
<b>Additional bibliography for study</b>	
<ul style="list-style-type: none"> <li>• Teaching material slides</li> </ul>	

## Materials Characterization

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	<b>MSEN 502</b>	<b>SEMESTER</b>	5 <sup>th</sup> Semester
<b>COURSE TITLE</b>	Materials Characterization		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		4 (3L + 1T)	6
<b>COURSE TYPE</b>	Background / General knowledge / Scientific area		
<b>PREREQUISITES</b>	Physical Chemistry, Inorganic Materials Chemistry		
<b>TEACHING AND EXAMINATION METHODS</b>	Face-to-face lectures and guided problem-solving sessions; short in-class quizzes; final written examination.		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes.		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p><b>Knowledge</b></p> <p>Upon successful completion of the course, students are expected to have acquired knowledge of the scientific principles governing the following topics: interaction of radiation with matter; basic principles and concepts of modern spectroscopic techniques in the field of Materials Science; elastic scattering theory; elastic scattering from individual atoms; X-ray and electron diffraction theory; secondary emission; radiation absorption by materials; radiation generation, detection, and measurement; X-ray Photoelectron Spectroscopy (XPS) and Auger Electron Spectroscopy (AES); electron microscopy (transmission and scanning); X-ray spectroscopy (EDS) for surface and interface analysis; UV-visible (UV-vis) spectroscopy, infrared spectroscopy (FT-IR), and Raman spectroscopy.</p> <p><b>Skills</b></p> <p>Upon successful completion of the course, students are expected to have developed skills related to: experimental techniques and instrumentation widely used in the structural and chemical analysis of materials, such as X-ray diffraction, X-ray Photoelectron Spectroscopy (XPS), Auger Electron</p>

	<p>Spectroscopy (AES), electron microscopy (transmission and scanning), and X-ray spectroscopy (EDS); UV–visible (UV-vis) spectroscopy, infrared spectroscopy (FT-IR), and Raman spectroscopy; the proper selection and use of specialized analytical experimental tools in Materials Science for the structural and chemical characterization of materials, including the identification of the appropriate operating regimes of each technique according to the requirements of a given experiment.</p> <p>Competences</p> <p>Upon successful completion of the course, students are expected to have developed the ability to: select and apply appropriate characterization techniques and experimental methodologies for the structural and chemical analysis of materials; and critically evaluate and appropriately use results reported in the scientific literature related to the characterization techniques presented, across different classes of materials.</p>
<p><b>General Skills</b></p>	<ul style="list-style-type: none"> <li>• Problem solving with quantitative reasoning</li> <li>• Teamwork in tutorial and lab-style activities</li> <li>• Information literacy (handbooks, databases, standards awareness)</li> <li>• Technical reporting and oral communication</li> <li>• Ethics and sustainability awareness in materials choices</li> </ul>

### 3. COURSE CONTENT

The course Materials Characterization provides an overview of the fundamental principles and techniques used to analyze the structure, composition, and properties of materials. It introduces different types of radiation and their relationship between energy and wavelength, atomic theory, and electronic energy levels, followed by a discussion of the interaction of radiation with matter, including electromagnetic waves, ionizing and non-ionizing radiation, and elastic scattering phenomena. The course covers the theory and applications of X-ray diffraction (XRD), including X-ray generation, absorption, detection, and basic crystallographic concepts, with emphasis on phase identification and structural analysis. Surface and near-surface characterization techniques such as X-ray Photoelectron Spectroscopy (XPS) and Auger Electron Spectroscopy (AES) are presented, along with Energy Dispersive X-ray Spectroscopy (EDS) for elemental analysis. The principles and instrumentation of electron microscopy, including Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM), are discussed and compared, highlighting their integration with spectroscopic methods. Finally, the course introduces optical spectroscopic techniques, including UV–visible spectroscopy, Fourier Transform Infrared (FT-IR) spectroscopy, and Raman spectroscopy, focusing on their physical principles, instrumentation, spectral interpretation, and representative applications in materials science.

### 4. LEARNING & TEACHING METHODS - EVALUATION

<p><b>Teaching method</b></p>	<p>Face-to-face. Lectures, guided problem sessions, short demonstrations, and small-group activities/case studies.</p>
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<b>Use of ICT</b>	Learning management system (e-learning platform) for notes, quizzes and announcements; spreadsheets for simple property charts; basic use of materials databases for information retrieval.																
<b>Teaching organization</b>	<p>The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).</p> <table border="1"> <thead> <tr> <th>Activity</th> <th>Workload/semester (hours)</th> </tr> </thead> <tbody> <tr> <td>Lectures</td> <td>39</td> </tr> <tr> <td>Tutorials / problem sessions</td> <td>13</td> </tr> <tr> <td>Short assignments / quizzes</td> <td>10</td> </tr> <tr> <td>Independent study</td> <td>70</td> </tr> <tr> <td>Exam preparation</td> <td>16</td> </tr> <tr> <td>Final written exam</td> <td>2</td> </tr> <tr> <td><b>Total</b></td> <td><b>150</b></td> </tr> </tbody> </table>	Activity	Workload/semester (hours)	Lectures	39	Tutorials / problem sessions	13	Short assignments / quizzes	10	Independent study	70	Exam preparation	16	Final written exam	2	<b>Total</b>	<b>150</b>
Activity	Workload/semester (hours)																
Lectures	39																
Tutorials / problem sessions	13																
Short assignments / quizzes	10																
Independent study	70																
Exam preparation	16																
Final written exam	2																
<b>Total</b>	<b>150</b>																
<b>Student evaluation</b>	<p>Assessment language: English.            Methods: written final exam (60%), homework/problem sets and short quizzes (25%), mini-case study/report (15%). Students are informed via the course guide and e-learning announcements.</p>																

## 5. SUGGESTED BIBLIOGRAPHY

### EUDOXUS

To be specified in EUDOXUS.

### Additional bibliography for study

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

## Ceramics

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	<b>MSEN 503</b>	<b>SEMESTER</b>	5 <sup>th</sup> Semester
<b>COURSE TITLE</b>	Ceramics		
<b>TEACHING ACTIVITIES</b>		<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.		4 (3L + 1T)	6
<b>COURSE TYPE</b>	Background / General knowledge / Scientific area		
<b>PREREQUISITES</b>	Physical Chemistry, Inorganic Materials Chemistry		
<b>TEACHING AND EXAMINATION METHODS</b>	Face-to-face lectures and guided problem-solving sessions; short in-class quizzes; final written examination.		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes.		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p>The aim of this course is to introduce students to ceramic materials, glass, glass-ceramic materials and binders, in terms of both science and engineering. The teaching of the science of ceramic materials aims at learning the properties of these materials, such as physical, chemical, electrical, optical, magnetic, as a result of their compositions. The teaching of ceramic engineering aims to learn all the experimental methods of manufacturing and testing ceramic materials as applied around the world. The interest of the course is focused on all categories of ceramic materials, and in terms of composition, e.g. oxides, carbides, nitrides, glass, binders (cement and gypsum), and in their form, e.g. powders, porous and solid materials, from macro- to micro- and nano-dimensions, and in terms of their final application, ie advanced ceramics, such as nano-tech ceramics, nano-composites and nano-dimensions, such as coatings.</p> <p>Competences</p> <p>The above are absolutely necessary (in terms of skills) for the Materials Engineer to design new ceramic material compositions with the desired properties as well as in the quality control of ceramic materials produced by the industry and marketed and applied in a number of applications, on the other hand are a particularly attractive perspective (and acquired skill) for the</p>

	<p>graduates of the Department as they match the particular characteristics of the Greek Economy, such as traditional ceramics, which is a cornerstone of a country's industry but also of Europe and internationally, but also advanced ceramics, which should be the future of the country's development in the near future. Thus, with regard to Understanding, the student must be able (that is, expected to be able) to distinguish, explain, evaluate and conclude the value and importance of the above knowledge as necessary to the Science and Technique of Ceramics as a key component of the Materials Engineering subject, and with regard to Application, the student is (that is, must be) able to use the knowledge both in the strict context of this course and in the context of the challenges he will face in practicing the profession of Materials Engineer, in industry or research.</p>
<p><b>General Skills</b></p>	<ul style="list-style-type: none"> <li>• Problem solving with quantitative reasoning</li> <li>• Teamwork in tutorial and lab-style activities</li> <li>• Information literacy (handbooks, databases, standards awareness)</li> <li>• Technical reporting and oral communication</li> <li>• Ethics and sustainability awareness in materials choices</li> </ul>

### 3. COURSE CONTENT

The course Ceramic Materials provides a comprehensive introduction to the science, technology, and applications of ceramics in materials science and industry. It begins with an overview of ceramics in various industrial and technological contexts and a discussion of raw materials and their properties. Students study the classification of ceramics into traditional and advanced categories and learn about processing and shaping techniques, including powder processing, sintering, and forming methods, as well as ceramic coatings. The course covers the atomic and crystalline structures of ceramics, as well as non-crystalline solids such as glasses, and introduces phase diagrams to understand phase equilibria and transformations. Key concepts of nucleation, crystal growth, devitrification, solid-state reactions, and non-equilibrium processing are addressed to explain microstructural development. Students explore the relationship between microstructure and a wide range of properties, including mechanical (strength, toughness), thermal (conductivity, expansion), optical (transparency, refractive index), electrical (dielectric, conductive behavior), and chemical stability (corrosion, oxidation). Emphasis is placed on understanding the interdependence of processing, structure, and properties, and on the critical evaluation of ceramics for engineering and technological applications. Through lectures, case studies, and practical examples, students develop the knowledge and skills necessary to select, design, and optimize ceramic materials for diverse applications.

### 4. LEARNING & TEACHING METHODS - EVALUATION

<p><b>Teaching method</b></p>	<p>Face-to-face. Lectures, guided problem sessions, short demonstrations, and small-group activities/case studies.</p>
<p><b>Use of ICT</b></p>	<p>Learning management system (e-learning platform) for notes, quizzes and announcements; spreadsheets for simple property charts; basic use of materials databases for information retrieval.</p>

<b>Teaching organization</b>	The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).	
	<b>Activity</b>	<b>Workload/semester (hours)</b>
	Lectures	39
	Tutorials / problem sessions	13
	Short assignments / quizzes	10
	Independent study	70
	Exam preparation	16
	Final written exam	2
<b>Total</b>	<b>150</b>	
<b>Student evaluation</b>	Assessment language: English. Methods: written final exam (60%), homework/problem sets and short quizzes (25%), mini-case study/report (15%). Students are informed via the course guide and e-learning announcements.	

## 5. SUGGESTED BIBLIOGRAPHY

### EUDOXUS

To be specified in EUDOXUS.

### Additional bibliography for study

- Barsoum M., Fundamentals of Ceramics, 2003 Institute of Physics Publishing, Bristol and Philadelphia

## Chemical Process Engineering

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	<b>MSEN 504</b>	<b>SEMESTER</b>	5 <sup>th</sup> Semester
<b>COURSE TITLE</b>	<b>Chemical Process Engineering</b>		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		4	6
<b>COURSE TYPE</b>	Background / General knowledge / Scientific area		
<b>PREREQUISITES</b>	No prerequisites		
<b>TEACHING AND EXAMINATION METHODS</b>	English		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes.		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p>This course focuses on the design and operation of industrial processes employed to transform and/or utilize raw or synthetic materials into functional products by applying principles from physics, chemistry, math, and biology. It focuses on unit operations (e.g. reactions, separations), material selection for equipment, and process design for efficiency, safety, and sustainability, bridging fundamental science with large-scale production for diverse sectors.</p> <p>More specifically, by the end of this course the students will be able to:</p> <ul style="list-style-type: none"> <li>• Understand the role of thermodynamics and transport phenomena (heat and mass transfer) in material development and processing, for example: <ul style="list-style-type: none"> <li>✓ Effect of external and internal mass transfer in reaction engineering and fuel cell systems</li> <li>✓ The role of thermodynamics and diffusion in crystallization</li> </ul> </li> <li>• Analyze and design and operation of basic physicochemical processes that involve the applications of different types of materials including:</li> </ul>

	<ul style="list-style-type: none"> <li>✓ Heterogeneous catalytic reactors</li> <li>✓ Fixed bed adsorbers and membranes for gas separations</li> <li>✓ Fuel cells</li> <li>✓ Controlled release systems for biomedical applications</li> </ul>
<b>General Skills</b>	<ul style="list-style-type: none"> <li>• Searching, analyzing and synthesizing data and information</li> <li>• Decision-making</li> <li>• Independent work</li> <li>• Teamwork</li> <li>• Generate new research ideas</li> <li>• Project planning and management emphasizing materials science</li> <li>• Promoting free, creative and inductive thinking</li> <li>• Modeling and solving real-world problems</li> <li>• Working in a multidisciplinary environment</li> </ul>

### 3. COURSE CONTENT

- Basic principles and definitions
- General mass and heat balances in macroscopic systems
- Mass transfer in microscopic systems: the diffusion equation
- Process systems engineering in selected applications:
  - ✓ Heterogeneous reaction engineering
  - ✓ Fixed bed adsorption and membrane technology for gas separations
  - ✓ Crystallization and filtration
  - ✓ Fuel cell systems

Biomedical applications: Controlled drug release

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face.
<b>Use of ICT</b>	<p>Use of ICT in Course Teaching, Use of ICT in Communication with Students</p> <p>Description: Use of Information and Communication Technologies (ICT) in teaching the course with tools of modern distance learning (ZOOM) and asynchronous education (eclass).</p> <p>Use of learning aids based on ICT: Excel, Word, Power Point</p> <p>Use of ICT in student assessment: Electronic grading (eclass, universis).</p> <ul style="list-style-type: none"> <li>• Use of ICT in communication with students: eclass, email, ZOOM.</li> </ul>

<b>Teaching organization</b>	The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).	
	<b>Activity</b>	<b>Workload/semester (hours)</b>
	Lectures	52
	Tutorials / problem sessions	13
	Bibliographic Research and analysis	83
	Final written exam	2
	<b>Total</b>	<b>150</b>
<b>Student evaluation</b>	Assessment Language: English Assessment Methods: <ul style="list-style-type: none"> <li>• Short Answer Questions,</li> <li>• Essay Development Questions,</li> <li>• Problem Solving</li> <li>• Written exams</li> <li>•</li> </ul>	

## 5. SUGGESTED BIBLIOGRAPHY

### Course Bibliography

“Perry’s Chemical Engineer’s Handbook” Don W. Green, Marylee Z. Southard, (McGraw Hill, 9<sup>th</sup> Edition), ISBN: 0-07-142294-3

“Transport Processes and Separation Process Principles” Christie Geankoplis, (Prentice Hall, 4<sup>th</sup> Edition), ISBN: 013101367X

“Heterogeneous Reactor Design” Hong Lee, (Butterworths, 4<sup>th</sup> Edition), ISBN: 0-409-95073-4

### Additional bibliography for study

Teaching material slides

## Mechanical behavior of Engineering Materials

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	<b>MSEN 505</b>	<b>SEMESTER</b>	5 <sup>th</sup> Semester
<b>COURSE TITLE</b>	<b>Mechanical behavior of Engineering Materials</b>		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		4 (3L + 1T)	6
<b>COURSE TYPE</b>	Mandatory / Scientific area / Skills development		
<b>PREREQUISITES</b>	No prerequisites		
<b>TEACHING AND EXAMINATION METHODS</b>	Face-to-face lectures and guided problem-solving sessions; short in-class quizzes; final written examination.		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p>By the end of this course, students will be able to:</p> <ul style="list-style-type: none"> <li>• Understand stress, strain, and displacement as fundamental quantities for the design of structural members.</li> <li>• Analyze and calculate structural stability, specifically regarding column buckling</li> <li>• Apply these concepts to the design and analysis of both statically determinate and indeterminate structures subjected to tension, compression, bending, shear, torsion, and combined loading</li> <li>• Utilize energy methods (such as Castigliano's theorems) for the analysis and design of structural members.</li> </ul>
<b>General Skills</b>	<ul style="list-style-type: none"> <li>• Search for, analysis and synthesis of data and information, with the use of the necessary technology</li> <li>• Work autonomously</li> <li>• Advance free, creative and causative thinking</li> <li>• Adapting to new situations</li> <li>• Decision-making</li> <li>• Modeling and solving real-world problems</li> <li>• Working in a multidisciplinary environment</li> </ul>

### 3. COURSE CONTENT

**Description:**

This course establishes the fundamental principles required to analyze the mechanical behavior of solid bodies under load. Bridging the gap between static equilibrium and structural design, students will explore the relationships between external loads, internal stresses, strains, and deformations. The course emphasizes the sizing and analysis of structural members—both statically determinate and indeterminate—subjected to various loading conditions, including tension, compression, bending, and torsion.

**Key topics:**

- Stress & Strain Analysis.
- Fundamental Loading Conditions.
- Combined Loading & Indeterminacy
- Structural Stability (Buckling)

### 4. LEARNING & TEACHING METHODS – EVALUATION

<b>Teaching method</b>	Face-to-face.																
<b>Use of ICT</b>	Use of ICT in Course Teaching, Use of ICT in Communication with Students Description: Use of Information and Communication Technologies (ICT) in teaching the course with tools of modern distance learning (MS-Teams) and asynchronous education (e-learning). Use of learning aids based on ICT: Excel Use of ICT in student assessment: Electronic grading (e-learning). Use of ICT in communication with students: e-learning, email, MS-Teams.																
<b>Teaching organization</b>	The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards). <table border="1" data-bbox="523 1272 1337 1554"> <thead> <tr> <th>Activity</th> <th>Workload/semester (hours)</th> </tr> </thead> <tbody> <tr> <td>Lectures</td> <td>39</td> </tr> <tr> <td>Tutorials / problem sessions</td> <td>13</td> </tr> <tr> <td>Short assignments / quizzes</td> <td>10</td> </tr> <tr> <td>Independent study</td> <td>70</td> </tr> <tr> <td>Exam preparation</td> <td>16</td> </tr> <tr> <td>Final written exam</td> <td>2</td> </tr> <tr> <td><b>Total</b></td> <td><b>150</b></td> </tr> </tbody> </table>	Activity	Workload/semester (hours)	Lectures	39	Tutorials / problem sessions	13	Short assignments / quizzes	10	Independent study	70	Exam preparation	16	Final written exam	2	<b>Total</b>	<b>150</b>
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Short assignments / quizzes	10																
Independent study	70																
Exam preparation	16																
Final written exam	2																
<b>Total</b>	<b>150</b>																
<b>Student evaluation</b>	Written Exams with Problem Solving with Short Answer Written Exams with Problem Solving (Summative)																

### 5. SUGGESTED BIBLIOGRAPHY

**EUDOXUS**

To be specified in EUDOXUS.

**Additional bibliography for study**

- Beer, F. P., Johnston, E. R., DeWolf, J. T., Jr., Mazurek, D. F. (2015). Mechanics of Materials (7th ed.). McGraw-Hill Education.

## 6<sup>th</sup> Semester

### Design of materials in the atomic scale

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	<b>MSEN 601</b>	<b>SEMESTER</b>	6 <sup>th</sup> Semester
<b>COURSE TITLE</b>	<b>Design of materials in the atomic scale</b>		
<b>TEACHING ACTIVITIES</b>	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>	
Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	4	6	
<b>COURSE TYPE</b>	This course introduces the principles and techniques for designing and understanding materials at the atomic and molecular level. Topics include atomic structure, bonding, crystal structures, defects, and computational modeling methods used to predict and tailor material properties. Emphasis is placed on linking atomic-scale phenomena to macroscopic material behavior, enabling students to design materials with desired mechanical, electronic, thermal, and chemical properties for advanced engineering applications.		
<b>PREREQUISITES</b>	This course builds on foundational knowledge in materials science, solid-state physics, chemistry, and crystallography. Students are expected to understand atomic structure, bonding, crystal lattices, and basic thermodynamics. Familiarity with computational methods or software for modeling atomic-scale systems is helpful but not required, as the course introduces relevant simulation and analysis techniques.		
<b>TEACHING AND EXAMINATION METHODS</b>	Lectures, Homework assignments, Quizzes, Midterm examination, Final exam		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes.		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p>Upon successful completion of the course, students will be able to:</p> <ul style="list-style-type: none"> <li>● Explain atomic and molecular structure, bonding, and crystal arrangements in materials.</li> <li>● Analyze the role of defects and atomic-scale phenomena in determining material properties.</li> <li>● Apply computational modeling and simulation techniques to predict material behavior at the atomic scale.</li> <li>● Relate atomic-level design decisions to macroscopic mechanical, thermal, electronic, and chemical properties.</li> <li>● Integrate theoretical knowledge and practical methods to design</li> </ul>

	<p>materials for specific engineering applications.</p> <ul style="list-style-type: none"> <li>Communicate atomic-scale materials design concepts clearly using written, graphical, and oral forms.</li> </ul>
<b>General Skills</b>	<p>Upon completing this course, students will develop the following skills:</p> <p><b>General Skills</b></p> <ol style="list-style-type: none"> <li><b>Analytical Thinking:</b> Ability to analyze atomic-scale structures and relate them to material properties.</li> <li><b>Problem-Solving:</b> Design materials with specific properties using theoretical and computational methods.</li> <li><b>Research Skills:</b> Evaluate scientific literature and apply advanced concepts to materials engineering problems.</li> <li><b>Engineering Application:</b> Translate atomic-scale understanding into practical materials solutions.</li> </ol> <p><b>Soft Skills</b></p> <ol style="list-style-type: none"> <li><b>Communication:</b> Present scientific results clearly in written, graphical, and oral formats.</li> <li><b>Teamwork:</b> Collaborate effectively in laboratory, simulation, or project-based group activities.</li> <li><b>Critical Thinking:</b> Assess design decisions and interpret computational and experimental results.</li> <li><b>Time Management:</b> Plan and execute projects and assignments efficiently.</li> </ol> <p><b>Adaptability and Lifelong Learning:</b> Apply knowledge to new materials challenges and stay updated with emerging techniques</p>

### 3. COURSE CONTENT

This course covers the principles of atomic and molecular structure, bonding, crystal structures, and defects, emphasizing their influence on material properties. Students learn computational modeling and simulation techniques to predict material behavior and apply atomic-scale design strategies to develop advanced materials for engineering applications. Course content includes:

- Atomic Structure and Bonding, Crystal Structures and Defects**
- Materials Properties at the Atomic Scale**
  - Mechanical, thermal, electronic, and optical behavior
  - Role of atomic arrangement in determining macroscopic properties
  - Structure–property relationships
- Computational Modeling and Simulation**
  - Molecular dynamics and Monte Carlo simulations
  - Density functional theory basics
  - Predicting material behavior and guiding design decisions
- Materials Design Strategies**
  - Tailoring atomic structure for desired properties
  - Design of alloys, composites, and nanostructured materials
  - Case studies of engineered materials
- Applications in Materials Engineering**
  - Advanced functional materials
  - Nanoengineered materials and devices

Linking atomic-scale design to industrial applications

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face.
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<b>Use of ICT</b>	<p>ICT plays a significant role in enhancing teaching, learning, experimentation, visualization, and assessment in this course as follows:</p> <p><b>Computational Tools for Problem Solving:</b> Spreadsheet calculations (Excel, Google Sheets), Coding solutions in Python, MATLAB, or Mathematica</p> <p><b>Online Learning Platforms:</b> Learning management systems (LMS) like Moodle, Online lectures, video tutorials, and animations,</p> <p><b>Communication and Collaboration:</b> Online discussion forums, Collaborative documents, Sharing of data and reports</p> <p><b>Presentation and Reporting Tools:</b> Lab reports (word processors), Data plots and charts (graphing tools), Presentations (PowerPoint, Google Slides).</p>												
<b>Teaching organization</b>	<p>The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).</p> <table border="1" data-bbox="528 786 1337 1003"> <thead> <tr> <th>Activity</th> <th>Workload/semester (hours)</th> </tr> </thead> <tbody> <tr> <td>Lectures</td> <td>52</td> </tr> <tr> <td>self-study, quizzes, on-line tests</td> <td>46</td> </tr> <tr> <td>Independent study</td> <td>50</td> </tr> <tr> <td>Final written exam</td> <td>2</td> </tr> <tr> <td><b>Total</b></td> <td><b>150</b></td> </tr> </tbody> </table>	Activity	Workload/semester (hours)	Lectures	52	self-study, quizzes, on-line tests	46	Independent study	50	Final written exam	2	<b>Total</b>	<b>150</b>
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Independent study	50												
Final written exam	2												
<b>Total</b>	<b>150</b>												
<b>Student evaluation</b>	<p>Assessment Language: English</p> <ul style="list-style-type: none"> <li>Assessment Methods: Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Written Exams</li> </ul>												

## 5. SUGGESTED BIBLIOGRAPHY

### Course Bibliography

Materials Interfaces | ISBN 978-0-412-41270-7 | Springer 1992

### Additional bibliography for study

Materials and Design: The Art and Science of Material Selection in Product Design | ISBN | Butterworth-Heinemann 2014

## Materials Characterization Laboratory

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	<b>MSEN 602</b>	<b>SEMESTER</b>	6 <sup>th</sup> Semester
<b>COURSE TITLE</b>	<b>Materials Characterization Laboratory</b>		
<b>TEACHING ACTIVITIES</b>	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>	
Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	Lectures: 1 Lab work: 3 Total: 4	6	
<b>COURSE TYPE</b>	Background, General Knowledge		
<b>PREREQUISITES</b>	No prerequisites		
<b>TEACHING AND EXAMINATION METHODS</b>	English		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes.		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p>Upon successful completion of the course, students will be able to:</p> <ul style="list-style-type: none"> <li>• Understand the principles and applications of modern materials characterization techniques.</li> <li>• Explain structure–property relationships at the atomic, crystallographic, and microstructural levels.</li> <li>• Select appropriate characterization methods (XRD, microscopy, spectroscopy, thermal and mechanical analysis) for different classes of materials.</li> <li>• Prepare samples and safely operate basic materials characterization equipment.</li> <li>• Acquire, analyze, and interpret experimental data, identifying sources of error and limitations.</li> <li>• Relate experimental results to material composition, structure, and properties.</li> <li>• Communicate experimental findings effectively through written laboratory reports and oral presentations.</li> </ul>
<b>General Skills</b>	1. Applying knowledge in practice

	<ol style="list-style-type: none"> <li>2. Searching, analyzing and synthesizing data and information, using the necessary spectroscopic technologies</li> <li>3. Decision-making</li> <li>4. Independent work</li> <li>5. Teamwork</li> <li>6. Generate new research ideas</li> <li>7. Promoting free, creative and inductive thinking</li> </ol>
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### 3. COURSE CONTENT

This course provides a comprehensive introduction to the experimental techniques used for the characterization of materials and the interpretation of structure-property relationships. Through a combination of lectures and hands-on laboratory sessions, students gain practical experience with modern characterization tools commonly used in materials science and engineering. Topics covered include crystallographic analysis using X-ray diffraction (XRD), microstructural characterization with optical microscopy and scanning electron microscopy (SEM), elemental analysis through energy-dispersive X-ray spectroscopy (EDS) and spectroscopy techniques (FT-IR and Raman). Additional experiments introduce thermal analysis techniques such as differential scanning calorimetry (DSC), as well as mechanical characterization methods including hardness testing and basic tensile testing. Emphasis is placed on proper sample preparation, experimental design, data acquisition, and quantitative data analysis. Students learn how to critically evaluate experimental results, identify sources of error, and relate observed material behavior to underlying atomic and microstructural features. By the end of the course, students will be able to select appropriate characterization techniques for different classes of materials, operate laboratory instrumentation safely and effectively, and communicate experimental findings clearly through written laboratory reports and oral presentations.

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face.										
<b>Use of ICT</b>	<p>ICT will be used in teaching the course, and in communication with students:</p> <ul style="list-style-type: none"> <li>• teaching of the course with modern distance learning (ZOOM) and asynchronous education tools via elearning platform of AUTH,</li> </ul> <p>communication with students via email, ZOOM, and elearning platform of AUTH.</p>										
<b>Teaching organization</b>	<p>The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center;">Activity</th> <th style="text-align: center;">Workload/semester (hours)</th> </tr> </thead> <tbody> <tr> <td>Lectures</td> <td style="text-align: center;">13</td> </tr> <tr> <td>Bibliographic research and analysis</td> <td style="text-align: center;">40</td> </tr> <tr> <td>Laboratory exercises</td> <td style="text-align: center;">39</td> </tr> <tr> <td>Writing of assignments</td> <td style="text-align: center;">56</td> </tr> </tbody> </table>	Activity	Workload/semester (hours)	Lectures	13	Bibliographic research and analysis	40	Laboratory exercises	39	Writing of assignments	56
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Bibliographic research and analysis	40										
Laboratory exercises	39										
Writing of assignments	56										

	Final written exam	2
	<b>Total</b>	<b>150</b>
<b>Student evaluation</b>	<p><b>Assessment language</b> The assessment language is English.</p> <p><b>Assessment methods</b> The course uses the following methods:</p> <ul style="list-style-type: none"> <li>• <b>Multiple choice tests:</b> two midterm exams to check recall of definitions, concepts, and terminology on core concepts on inorganic materials.</li> <li>• <b>Problem solving assignments:</b> two written assignments in which students review a class of inorganic materials, analyze literature data, and solve problems on inorganic materials.</li> <li>• <b>Final written exam:</b> it combines short answers, problem solving, and data interpretation questions to evaluate cumulative understanding on core concepts of inorganic materials.</li> </ul> <p>Weighting</p> <ul style="list-style-type: none"> <li>• Multiple choice tests): 20%</li> <li>• Problem solving assignments: 20%</li> <li>• Final written exam: 60%</li> </ul> <p><b>Student information</b> Students are informed about the assessment process through:</p> <ul style="list-style-type: none"> <li>• The course outline distributed in the first lecture.</li> <li>• Detailed instructions for the written assignment and presentation posted on the course website.</li> <li>• A dedicated assessment briefing during tutoring time where expectations and criteria are explained</li> </ul>	

## 5. SUGGESTED BIBLIOGRAPHY

### Course Bibliography

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### Additional bibliography for study

Teaching material slides

## Industrial Process Design and Economics

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	<b>MSEN 603</b>	<b>SEMESTER</b>	6 <sup>th</sup> Semester
<b>COURSE TITLE</b>	<b>Industrial Process Design and Economics</b>		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		Lectures: 2 Lab work: 2 Total: 4	6
<b>COURSE TYPE</b>	Background		
<b>PREREQUISITES</b>	No prerequisites		
<b>TEACHING AND EXAMINATION METHODS</b>	English		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes.		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p>By the end of this course, students will be able to:</p> <ul style="list-style-type: none"> <li>• Conduct complete techno-economic feasibility studies for chemical processes, with emphasis on materials processing industry.</li> <li>• Employ specialized software tools for the design and economic evaluation of an industrial plant.</li> <li>• Develop and interpret methodological flow diagrams, and apply mass and energy balance principles to process systems.</li> <li>• Perform preliminary sizing and selection of major process equipment based on design requirements and operating conditions.</li> <li>• Carry out cost estimation, economic evaluation, and profitability assessment of materials processing industrial projects.</li> <li>• Analyze process throughput, identify bottlenecks, and propose effective debottlenecking strategies.</li> <li>• Optimize process operating conditions using techno-economic criteria and apply scale-up principles to industrial systems.</li> <li>• Determine and evaluate processing parameters in outlet streams to ensure regulatory compliance and sustainable operation.</li> </ul>
<b>General Skills</b>	<ul style="list-style-type: none"> <li>• Search for, analysis and synthesis of data and information, with the use of the necessary technology</li> <li>• Decision-making</li> </ul>

	<ul style="list-style-type: none"> <li>• Team-work</li> <li>• Generate new research ideas</li> <li>• Project planning and management with emphasis on the environmental dimension</li> <li>• Modeling and solving real-world problems</li> <li>• Working in a multidisciplinary environment</li> <li>• Respect for the natural environment</li> </ul>
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### 3. COURSE CONTENT

The course introduces students to the application of techno-economic feasibility studies in chemical process industries, with particular emphasis on materials processing industrial plants. It is based on a thorough feasibility study of a selected plant, which varies each year, and the preparation of a detailed report that constitutes an important part of the overall course grade. The course covers the development and interpretation of methodological flow diagrams and the application of mass and energy balances for process analysis. Students learn the preliminary sizing and selection of key process equipment, as well as methods for cost estimation, economic evaluation, and assessment of project profitability. To support this, the course includes an extensive lab component where students use specialized software tools for plant design and economic evaluation. The course also addresses throughput analysis, identification of bottlenecks, and strategies for process optimization. Additionally, students explore the optimization of operating conditions using techno-economic criteria and the principles of process scale-up. Finally, the course examines the determination and evaluation of processing parameters in outlet streams to ensure compliance with material quality standards and sustainable operation.

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face.														
<b>Use of ICT</b>	<p>Use of ICT in Course Teaching, Use of ICT in Laboratory Teaching, Use of ICT in Communication with Students</p> <p>Description: Use of Information and Communication Technologies (ICT) in teaching the course with tools of modern distance learning (ZOOM) and asynchronous education (eclass).</p> <p>Use of learning aids based on ICT: Excel</p> <p>Use of ICT in student assessment: Electronic grading (eclass, universis).</p> <p>Use of ICT in communication with students: eclass, email, ZOOM.</p>														
<b>Teaching organization</b>	<p>The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).</p> <table border="1" data-bbox="523 1556 1337 1832"> <thead> <tr> <th>Activity</th> <th>Workload/semester (hours)</th> </tr> </thead> <tbody> <tr> <td>Lectures</td> <td>26</td> </tr> <tr> <td>Bibliographic research and analysis</td> <td>50</td> </tr> <tr> <td>Laboratory exercises</td> <td>22</td> </tr> <tr> <td>Writing of assignments</td> <td>50</td> </tr> <tr> <td>Final written exam</td> <td>2</td> </tr> <tr> <td><b>Total</b></td> <td><b>150</b></td> </tr> </tbody> </table>	Activity	Workload/semester (hours)	Lectures	26	Bibliographic research and analysis	50	Laboratory exercises	22	Writing of assignments	50	Final written exam	2	<b>Total</b>	<b>150</b>
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Lectures	26														
Bibliographic research and analysis	50														
Laboratory exercises	22														
Writing of assignments	50														
Final written exam	2														
<b>Total</b>	<b>150</b>														
<b>Student evaluation</b>	<p>Assessment Language: English</p> <p>Assessment Methods:</p> <ul style="list-style-type: none"> <li>• Written assignment</li> <li>• Problem Solving</li> <li>• Presentation in audience</li> <li>• Laboratory report</li> </ul>														

## 5. SUGGESTED BIBLIOGRAPHY

### Course Bibliography

Peters, M. S., Timmerhaus, K. D., & West, R. E. (2003). Plant design and economics for chemical engineers (5th ed.). McGraw-Hill.

### Additional bibliography for study

Developing An Industrial Chemical Process: An Integrated Approach. Author, Joseph Mizrahi. Edition, illustrated. Publisher, CRC Press, 2002.

## Engineering Laboratory (mechanical testing, non destructive testing)

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	<b>MSEN 604</b>	<b>SEMESTER</b>	6 <sup>th</sup> Semester
<b>COURSE TITLE</b>	<b>Engineering Laboratory (mechanical testing, non destructive testing)</b>		
<b>TEACHING ACTIVITIES</b>	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>	
Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	Lectures: 1 Lab work: 3 Total: 4	6	
<b>COURSE TYPE</b>	Background, General Knowledge		
<b>PREREQUISITES</b>	No prerequisites		
<b>TEACHING AND EXAMINATION METHODS</b>	English		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes.		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p>Upon successful completion of the course, undergraduate students will be able to:</p> <ul style="list-style-type: none"> <li>• Describe the basic mechanical behavior of engineering materials under common loading conditions.</li> <li>• Conduct standard mechanical tests (tensile, bending, impact, hardness, fatigue) following established testing procedures.</li> <li>• Identify elastic and plastic deformation, fracture behavior, and typical failure modes in metals, polymers, ceramics, and composites.</li> <li>• Understand the basic principles and practical applications of common non-destructive testing (NDT) methods.</li> <li>• Select appropriate mechanical or non-destructive testing techniques for simple engineering problems.</li> <li>• Record, analyze, and interpret experimental data, recognizing basic sources of error.</li> <li>• Follow safe laboratory practices and clearly report</li> </ul>

	experimental results in written and oral form.
<b>General Skills</b>	<ul style="list-style-type: none"> <li>• Applying knowledge in practice</li> <li>• Searching, analyzing and synthesizing data and information, using the necessary spectroscopic technologies</li> <li>• Decision-making</li> <li>• Independent work</li> <li>• Teamwork</li> <li>• Generate new research ideas</li> <li>• Promoting free, creative and inductive thinking</li> </ul>

### 3. COURSE CONTENT

This course provides a comprehensive introduction to experimental methods used for the mechanical characterization and non-destructive evaluation of engineering materials and components. The course integrates theoretical background with hands-on laboratory practice, enabling students to understand material behavior under different loading and service conditions. Laboratory experiments focus on mechanical testing techniques such as tensile, compression, bending, impact, fatigue, and hardness testing. Students investigate elastic and plastic deformation, fracture mechanisms, and failure modes in metals, polymers, ceramics, and composite materials. Data acquisition systems and standardized testing procedures (ASTM/ISO) are emphasized. In parallel, the course introduces fundamental non-destructive testing (NDT) methods used in industrial quality control and structural integrity assessment. Techniques include ultrasonic testing, radiographic inspection, magnetic particle testing, dye penetrant testing, and basic eddy current methods. Students learn the principles, capabilities, and limitations of each technique. Emphasis is placed on experimental planning, safe laboratory practice, data analysis, uncertainty evaluation, and technical reporting. Upon completion, students will be able to select appropriate mechanical and non-destructive testing methods, interpret experimental results, and assess material performance and structural reliability in engineering applications.

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face.								
<b>Use of ICT</b>	<p>ICT will be used in teaching the course, and in communication with students:</p> <ul style="list-style-type: none"> <li>• teaching of the course with modern distance learning (ZOOM) and asynchronous education tools via elearning platform of AUTH,</li> <li>• communication with students via email, ZOOM, and elearning platform of AUTH.</li> </ul>								
<b>Teaching organization</b>	<p>The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).</p> <table border="1"> <thead> <tr> <th>Activity</th> <th>Workload/semester (hours)</th> </tr> </thead> <tbody> <tr> <td>Lectures</td> <td>13</td> </tr> <tr> <td>Bibliographic research and analysis</td> <td>40</td> </tr> <tr> <td>Laboratory exercises</td> <td>39</td> </tr> </tbody> </table>	Activity	Workload/semester (hours)	Lectures	13	Bibliographic research and analysis	40	Laboratory exercises	39
Activity	Workload/semester (hours)								
Lectures	13								
Bibliographic research and analysis	40								
Laboratory exercises	39								

	Writing of assignments	56
	Final written exam	2
	<b>Total</b>	<b>150</b>
<b>Student evaluation</b>	<p><b>Assessment language</b> The assessment language is English.</p> <p><b>Assessment methods</b> The course uses the following methods:</p> <ul style="list-style-type: none"> <li>• <b>Multiple choice tests:</b> two midterm exams to check recall of definitions, concepts, and terminology on core concepts on inorganic materials.</li> <li>• <b>Problem solving assignments:</b> two written assignments in which students review a class of inorganic materials, analyze literature data, and solve problems on inorganic materials.</li> <li>• <b>Final written exam:</b> it combines short answers, problem solving, and data interpretation questions to evaluate cumulative understanding on core concepts of inorganic materials.</li> </ul> <p>Weighting</p> <ul style="list-style-type: none"> <li>• Multiple choice tests): 20%</li> <li>• Problem solving assignments: 20%</li> <li>• Final written exam: 60%</li> </ul> <p><b>Student information</b> Students are informed about the assessment process through:</p> <ul style="list-style-type: none"> <li>• The course outline distributed in the first lecture.</li> <li>• Detailed instructions for the written assignment and presentation posted on the course website.</li> <li>• A dedicated assessment briefing during tutoring time where expectations and criteria are explained.</li> </ul>	

## 5. SUGGESTED BIBLIOGRAPHY

### Course Bibliography

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### Additional bibliography for study

Teaching material slides

## Composite materials

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	MSEN 605	<b>SEMESTER</b>	6th Semester
<b>COURSE TITLE</b>	<b>Composite materials</b>		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		4 (3L + 1T)	6
<b>COURSE TYPE</b>	Scientific area / Skill development		
<b>PREREQUISITES</b>	Introduction to Materials Science and Engineering; Introduction to Solid Mechanics (or equivalent).		
<b>TEACHING AND EXAMINATION METHODS</b>	Lectures and problem sessions; case studies on structural composites; final written exam and a design-oriented assignment.		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes (taught in English, subject to minimum enrollment).		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<ul style="list-style-type: none"> <li>• Differentiate polymer-, metal- and ceramic-matrix composites and identify suitable applications.</li> <li>• Analyze the role of reinforcement geometry and orientation on composite stiffness and strength.</li> <li>• Explain processing routes for particulate, whisker, and fiber composites and link processing to defects.</li> <li>• Assess interface phenomena (wetting, adhesion, interphase) and their impact on performance and durability.</li> <li>• Apply simplified micromechanics models (rule of mixtures, load transfer) for preliminary design.</li> <li>• Recognize key failure modes (matrix cracking, delamination, fiber breakage) and propose mitigation strategies.</li> </ul>
<b>General Skills</b>	<ul style="list-style-type: none"> <li>• Engineering analysis with simplified models</li> <li>• Design thinking and trade-off evaluation</li> <li>• Use of technical literature and datasheets</li> <li>• Teamwork and presentation of a design case</li> </ul>

### 3. COURSE CONTENT

- Introduction and classification of composites; property advantages and limitations.
- Reinforcements: particles, whiskers, continuous fibers; textiles and architectures.
- Polymer matrix composites: processing (hand lay-up, RTM, prepreg/autoclave), defects and QA.
- Metal matrix and ceramic matrix composites: processing routes and high-temperature behavior.
- Micromechanics: stiffness predictions; strength and load transfer; laminate concepts (intro).
- Interfaces and interphases: bonding, residual stresses, environmental degradation.
- Failure and damage: matrix cracking, delamination, impact, fatigue; NDT overview.
- Composite design case studies (aerospace, automotive, energy, civil).
- Recycling and sustainability challenges for composites (overview).

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face. Lectures, problem-solving tutorials, and case-study discussions; optional lab/demo sessions.	
<b>Use of ICT</b>	E-learning for notes; spreadsheets or simple scripts for micromechanics calculations; optional use of CAE tools for laminate basics (demo level).	
<b>Teaching organization</b>	The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).	
	<b>Activity</b>	<b>Workload/semester (hours)</b>
	Lectures	39
	Tutorials / problem sessions	13
	Design assignment / case study	18
	Independent study	62
	Exam preparation	16
	Final written exam	2
<b>Total</b>	<b>150</b>	
<b>Student evaluation</b>	Assessment language: English. Methods: written final exam (60%), design assignment/report (25%), quizzes/problem sets (15%). Students are informed via the course guide and e-learning announcements.	

### 5. SUGGESTED BIBLIOGRAPHY

#### EUDOXUS

To be specified in EUDOXUS.

#### Additional bibliography for study

- R.M. Jones, Mechanics of Composite Materials.
- D. Hull & T.W. Clyne, An Introduction to Composite Materials.
- A. Kelly & C. Zweben (eds.), Comprehensive Composite Materials (selected chapters).
- M.F. Ashby, Materials Selection in Mechanical Design (composites selection sections).

## 7<sup>th</sup> Semester

### Materials selection in engineering design

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	MSEN 701	<b>SEMESTER</b>	7th Semester
<b>COURSE TITLE</b>	<b>Materials selection in engineering design</b>		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		4 (2L + 2Lab/Comp)	6
<b>COURSE TYPE</b>	Skill development / Scientific area		
<b>PREREQUISITES</b>	Introduction to Materials Science and Engineering; basic Mechanics of Materials.		
<b>TEACHING AND EXAMINATION METHODS</b>	Lectures plus computer-lab sessions using material property databases and charts; project-based assessment; final written exam.		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes (taught in English, subject to minimum enrollment).		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<ul style="list-style-type: none"> <li>• Translate design requirements into performance indices and selection criteria.</li> <li>• Use material property charts and databases to screen and rank candidate materials and processes.</li> <li>• Incorporate manufacturing constraints, joining, tolerances, and surface treatments into selection decisions.</li> <li>• Account for degradation mechanisms (corrosion, wear, fatigue) and apply basic failure analysis reasoning.</li> <li>• Perform preliminary cost and environmental impact comparisons to support design decisions.</li> <li>• Document and justify a defensible materials selection for a product component.</li> </ul>
<b>General Skills</b>	<ul style="list-style-type: none"> <li>• Systems thinking in design decisions</li> <li>• Data-driven decision making with uncertainty</li> <li>• Project planning and teamwork</li> </ul>

	<ul style="list-style-type: none"> <li>Professional reporting and presentations</li> </ul>
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### 3. COURSE CONTENT

- The role of materials selection in product development; requirements and constraints.
- Performance indices and Ashby-type methodology; screening and ranking.
- Materials property charts; multi-objective selection and trade-offs.
- Materials and process compatibility; joining and surface engineering options.
- Cost modeling concepts and sensitivity; availability and supply risk considerations (overview).
- Degradation and reliability: corrosion, wear, fatigue; failure analysis basics.
- Selection for functional requirements: thermal management, electrical, optical, magnetic (overview).
- Sustainability and circularity metrics in selection (overview / introduction).
- Case studies using databases and real components.

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face. Lectures plus hands-on computer labs and case-study workshops.																
<b>Use of ICT</b>	Computer-lab sessions using materials/property databases and charting tools; e-learning for datasets, templates, and submission; spreadsheet/Python for ranking and sensitivity analyses.																
<b>Teaching organization</b>	<p>The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 60%;">Activity</th> <th style="width: 40%;">Workload/semester (hours)</th> </tr> </thead> <tbody> <tr> <td>Lectures</td> <td style="text-align: center;">26</td> </tr> <tr> <td>Computer laboratories / workshops</td> <td style="text-align: center;">26</td> </tr> <tr> <td>Project (team) and report</td> <td style="text-align: center;">24</td> </tr> <tr> <td>Independent study</td> <td style="text-align: center;">56</td> </tr> <tr> <td>Exam preparation</td> <td style="text-align: center;">16</td> </tr> <tr> <td>Final written exam</td> <td style="text-align: center;">2</td> </tr> <tr> <td><b>Total</b></td> <td style="text-align: center;"><b>150</b></td> </tr> </tbody> </table>	Activity	Workload/semester (hours)	Lectures	26	Computer laboratories / workshops	26	Project (team) and report	24	Independent study	56	Exam preparation	16	Final written exam	2	<b>Total</b>	<b>150</b>
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Independent study	56																
Exam preparation	16																
Final written exam	2																
<b>Total</b>	<b>150</b>																
<b>Student evaluation</b>	<p>Assessment language: English.</p> <p>Methods: written final exam (40%), team project/report and presentation (40%), quizzes/short assignments (20%). Students are informed via the course guide and e-learning announcements.</p>																

### 5. SUGGESTED BIBLIOGRAPHY

#### EUDOXUS

To be specified in EUDOXUS.

#### Additional bibliography for study

- M.F. Ashby, Materials Selection in Mechanical Design.
- M.F. Ashby & K. Johnson, Materials and Design.
- ASM Handbooks (selected sections) and materials datasheets.

- Selected open courseware notes (indicative): Northwestern Materials Selection course materials.

## Materials Processing

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	MSEN 702	<b>SEMESTER</b>	7th Semester
<b>COURSE TITLE</b>	<b>Materials Processing</b>		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		4 (3L + 1T)	6
<b>COURSE TYPE</b>	Skill development / Scientific area		
<b>PREREQUISITES</b>	Introduction to Materials Science and Engineering; basic Mechanics of Materials.		
<b>TEACHING AND EXAMINATION METHODS</b>			
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes (taught in English, subject to minimum enrollment).		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p>Upon successful completion of the course, undergraduate students will be able to:</p> <ul style="list-style-type: none"> <li>• Describe the fundamental principles of materials processing and manufacturing.</li> <li>• Explain basic solidification processes, phase transformations, and microstructural evolution during materials processing.</li> <li>• Identify common processing methods for metals, polymers, ceramics, and composite materials.</li> <li>• Explain how processing routes influence the mechanical, thermal, and functional properties of materials.</li> <li>• Recognize common processing defects and their impact on material performance.</li> <li>• Select appropriate processing methods for simple engineering applications based on material type and desired properties.</li> </ul>
<b>General Skills</b>	<ul style="list-style-type: none"> <li>• Systems thinking in design decisions</li> </ul>

	<ul style="list-style-type: none"> <li>• Data-driven decision making with uncertainty</li> <li>• Project planning and teamwork</li> <li>• Professional reporting and presentations</li> </ul>
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### 3. COURSE CONTENT

This course provides a comprehensive introduction to the fundamental principles of materials processing and manufacturing. Topics include solidification, phase transformations, and microstructural evolution during processing, as well as processing methods for metals, polymers, ceramics, and composite materials. The influence of processing routes on mechanical, thermal, and functional properties is examined, with emphasis on process selection, defect formation, and performance optimization in engineering applications.

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face.	
<b>Use of ICT</b>	Learning management system (e-learning platform) for notes, quizzes and announcements; spreadsheets for simple property charts; basic use of materials databases for information retrieval.	
<b>Teaching organization</b>	The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).	
	<b>Activity</b>	<b>Workload/semester (hours)</b>
	Lectures	39
	Tutorials / problem sessions	13
	Short assignments / quizzes	10
	Independent study	70
	Exam preparation	16
	Final written exam	2
	<b>Total</b>	<b>150</b>
<b>Student evaluation</b>	Assessment language: English. Methods: written final exam (60%), homework/problem sets and short quizzes (25%), mini-case study/report (15%). Students are informed via the course guide and e-learning announcements.	

### 5. SUGGESTED BIBLIOGRAPHY

#### EUDOXUS

To be specified in EUDOXUS.

#### Additional bibliography for study

Teaching material slides

## Fundamentals of Additive Manufacturing

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	MSEN 711	<b>SEMESTER</b>	7th Semester
<b>COURSE TITLE</b>	<b>Fundamentals of Additive Manufacturing</b>		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		4 (2L + 2Lab)	6
<b>COURSE TYPE</b>	Scientific area / Skill development		
<b>PREREQUISITES</b>	Introduction to Materials Science and Engineering; basic CAD familiarity recommended.		
<b>TEACHING AND EXAMINATION METHODS</b>	Lectures plus laboratory/workshop sessions; team project on Design for Additive Manufacturing (DfAM); final exam and project deliverables.		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes (taught in English, subject to minimum enrollment).		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<ul style="list-style-type: none"> <li>Describe major AM process families (polymer, metal, ceramic) and their process-structure-property relationships.</li> <li>Select AM processes based on part requirements, material constraints, and economic considerations.</li> <li>Apply Design for Additive Manufacturing (DfAM) rules for geometry, supports, tolerances, and anisotropy.</li> <li>Identify typical AM defects (porosity, lack of fusion, residual stresses) and propose mitigation strategies.</li> <li>Plan post-processing routes (heat treatment, HIP, machining, surface finishing) appropriate to the process.</li> <li>Execute a basic AM workflow from design to build preparation to evaluation within a team project.</li> </ul>
<b>General Skills</b>	<ul style="list-style-type: none"> <li>Hands-on engineering practice and safety awareness</li> <li>Teamwork and project management</li> <li>Digital skills (CAD, slicing/build preparation)</li> <li>Critical evaluation of emerging technologies</li> </ul>

### 3. COURSE CONTENT

- AM overview: opportunities, limitations, and industrial adoption.
- Polymer AM: material extrusion, vat photopolymerization, powder bed fusion (polymers).
- Metal AM: laser/e-beam powder bed fusion, directed energy deposition; feedstocks and machines.
- Ceramic and composite AM (overview) and emerging multi-material printing.
- DfAM fundamentals: topology optimization concepts (overview), lattice structures, support strategies.
- Process-structure-property: thermal histories, anisotropy, microstructure, residual stresses.
- Quality assurance: in-situ monitoring (overview), inspection, mechanical testing, standards overview.
- Post-processing: stress relief, heat treatment, HIP, machining, surface finishing.
- Economics and sustainability of AM; case studies and a team project.

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face. Lectures, hands-on lab/workshop sessions, and a team design-and-build project.	
<b>Use of ICT</b>	CAD and build preparation software in lab sessions; e-learning for tutorials and submissions; use of simulation/monitoring datasets (where available).	
<b>Teaching organization</b>	The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).	
	<b>Activity</b>	<b>Workload/semester (hours)</b>
	Lectures	26
	Laboratories / workshops	26
	Team project (design-build-evaluate)	30
	Independent study	50
	Exam preparation	16
	Final written exam	2
<b>Total</b>	<b>150</b>	
<b>Student evaluation</b>	Assessment language: English. Methods: final exam (35%), team project deliverables (report/design files/print evaluation) (45%), quizzes/short assignments (20%). Students are informed via the course guide and e-learning announcements.	

### 5. SUGGESTED BIBLIOGRAPHY

#### EUDOXUS

To be specified in EUDOXUS.

#### Additional bibliography for study

- I. Gibson, D.W. Rosen & B. Stucker, Additive Manufacturing Technologies.
- T. Wohlers (ed.), Wohlers Report (selected recent editions, where available).
- ISO/ASTM standards and guidelines for additive manufacturing (selected).

- Selected open courseware notes (indicative): MIT additive manufacturing course materials.

## Powder metallurgy

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	MSEN 712	<b>SEMESTER</b>	7th Semester
<b>COURSE TITLE</b>	<b>Powder metallurgy</b>		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		4 (3L + 1T)	6
<b>COURSE TYPE</b>	Scientific area / Skill development		
<b>PREREQUISITES</b>	Introduction to Materials Science and Engineering; Thermodynamics recommended.		
<b>TEACHING AND EXAMINATION METHODS</b>	Lectures and tutorials; analysis of powder characterization data; final written exam and a short technical report.		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes (taught in English, subject to minimum enrollment).		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<ul style="list-style-type: none"> <li>• Explain powder production routes and relate powder characteristics to processability.</li> <li>• Select and apply powder characterization methods (particle size, morphology, flowability, density).</li> <li>• Analyze compaction and shaping mechanisms and their influence on green density and defects.</li> <li>• Describe sintering mechanisms (solid-state and liquid-phase) and predict densification trends.</li> <li>• Assess full-density consolidation routes (HIP, forging of PM preforms) and links to AM feedstocks.</li> <li>• Choose powder metallurgy routes for specific components considering performance, cost, and sustainability.</li> </ul>
<b>General Skills</b>	<ul style="list-style-type: none"> <li>• Experimental data interpretation and reporting</li> <li>• Quantitative reasoning on process parameters</li> <li>• Awareness of industrial constraints and quality assurance</li> <li>• Independent learning from standards and technical literature</li> </ul>

### 3. COURSE CONTENT

- Introduction to powder metallurgy and applications (structural parts, filters, magnetic materials, hardmetals).
- Powder production methods: atomization, reduction, electrolysis, mechanical milling; powder recycling.
- Powder characterization: size/shape distributions, surface area, flow, apparent and tap density.
- Compaction and shaping: uniaxial pressing, CIP, powder injection molding; binders and lubricants.
- Sintering fundamentals: diffusion mechanisms, neck growth, densification, grain growth; liquid-phase sintering.
- Post-processing: sizing, heat treatment, infiltration, surface treatments.
- Full-density processes: HIP, hot pressing, forging/rolling of PM preforms; links to AM (powder bed).
- Defects, quality assurance, and standards; safety aspects (dust, handling).
- Design for powder metallurgy and case studies.

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face. Lectures and tutorials supported by data-analysis exercises and case studies; optional lab demonstrations.																
<b>Use of ICT</b>	E-learning for notes; spreadsheets for particle size and densification calculations; optional image analysis software for powder morphology (demo).																
<b>Teaching organization</b>	<p>The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).</p> <table border="1"> <thead> <tr> <th>Activity</th> <th>Workload/semester (hours)</th> </tr> </thead> <tbody> <tr> <td>Lectures</td> <td>39</td> </tr> <tr> <td>Tutorials / problem sessions</td> <td>13</td> </tr> <tr> <td>Data analysis / short report</td> <td>16</td> </tr> <tr> <td>Independent study</td> <td>64</td> </tr> <tr> <td>Exam preparation</td> <td>16</td> </tr> <tr> <td>Final written exam</td> <td>2</td> </tr> <tr> <td><b>Total</b></td> <td><b>150</b></td> </tr> </tbody> </table>	Activity	Workload/semester (hours)	Lectures	39	Tutorials / problem sessions	13	Data analysis / short report	16	Independent study	64	Exam preparation	16	Final written exam	2	<b>Total</b>	<b>150</b>
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<b>Total</b>	<b>150</b>																
<b>Student evaluation</b>	<p>Assessment language: English.            Methods: written final exam (60%), technical report/data-analysis assignment (25%), quizzes/problem sets (15%). Students are informed via the course guide and e-learning announcements.</p>																

### 5. SUGGESTED BIBLIOGRAPHY

#### EUDOXUS

To be specified in EUDOXUS.

#### Additional bibliography for study

- R.M. German, Powder Metallurgy and Particulate Materials Processing.
- A. Lawley (ed.), Powder Metallurgy (selected chapters).
- ASM Handbook, Volume 7: Powder Metallurgy.
- Selected university course notes (indicative): KTH Powder Metallurgy topics and notes.

## Materials Circular Economy and LCA

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	MSEN 713	<b>SEMESTER</b>	7th Semester
<b>COURSE TITLE</b>	<b>Materials Circular Economy and LCA</b>		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		4 (2L + 2Lab/Comp)	6
<b>COURSE TYPE</b>	Skill development / Scientific area		
<b>PREREQUISITES</b>	Introduction to Materials Science and Engineering. Recommended: Thermodynamics and Materials Processing.		
<b>TEACHING AND EXAMINATION METHODS</b>	Lectures plus computer-lab sessions on life cycle thinking and LCA modelling; case studies; final project and written exam.		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes (taught in English, subject to minimum enrollment).		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<ul style="list-style-type: none"> <li>• Explain circular economy principles and their specific implications for materials and product systems.</li> <li>• Set up the goal and scope of an LCA study (functional unit, system boundaries, assumptions).</li> <li>• Perform simplified life cycle inventory (LCI) modelling and interpret key data requirements.</li> <li>• Interpret life cycle impact assessment (LCIA) results and understand main categories and limitations.</li> <li>• Compare circularity strategies (reuse, repair, remanufacture, recycle) using quantitative and qualitative criteria.</li> <li>• Communicate LCA and circularity results transparently, including uncertainty and sensitivity considerations.</li> </ul>
<b>General Skills</b>	<ul style="list-style-type: none"> <li>• Sustainability literacy and systems thinking</li> <li>• Data handling and modelling skills</li> <li>• Critical evaluation of assumptions and uncertainty</li> <li>• Teamwork on case-study-based projects</li> </ul>

### 3. COURSE CONTENT

- Materials and sustainability: resource use, emissions, and circularity metrics (overview).
- Circular economy principles and strategies (design for R: reuse, repair, remanufacture, recycle).
- Life cycle thinking: product systems, functional unit, system boundaries, allocation.
- Life cycle inventory (LCI): data sources, primary vs secondary data, data quality.
- Life cycle impact assessment (LCIA): main categories and interpretation; limitations.
- Life cycle costing (LCC) and social LCA (overview).
- Circularity indicators and integration with LCA; design-integrated approaches.
- Case studies: metals, polymers, batteries/critical materials, composites; end-of-life scenarios.
- Software/lab sessions for simplified LCA modelling and scenario comparison.

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face. Lectures, computer laboratories, and case-study workshops with a team project.	
<b>Use of ICT</b>	Computer labs using an LCA tool (e.g., openLCA or equivalent) and spreadsheets; e-learning for datasets/templates; collaborative platforms for group work and reporting.	
<b>Teaching organization</b>	The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).	
	<b>Activity</b>	<b>Workload/semester (hours)</b>
	Lectures	26
	Computer laboratories / workshops	26
	Team project and report	28
	Independent study	52
	Exam preparation	16
	Final written exam	2
<b>Total</b>	<b>150</b>	
<b>Student evaluation</b>	Assessment language: English. Methods: project/report and presentation (45%), written final exam (35%), quizzes/short assignments (20%). Students are informed via the course guide and e-learning announcements.	

### 5. SUGGESTED BIBLIOGRAPHY

#### EUDOXUS

To be specified in EUDOXUS.

#### Additional bibliography for study

- ISO 14040/14044 standards (overview) and selected guidance documents.
- M. Finkbeiner (ed.), Life Cycle Assessment: Theory and Practice (selected chapters).
- Selected course notes on LCA and circular design (indicative): TU Delft / ETH LCA materials.
- Relevant journal review papers and case studies provided by the instructor.

## Surfaces and Interfaces and Thin-Film Materials Science

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	<b>MSEN 721</b>	<b>SEMESTER</b>	7 <sup>th</sup> Semester
<b>COURSE TITLE</b>	<b>Surfaces and Interfaces and Thin-Film Materials Science</b>		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		4	6
<b>COURSE TYPE</b>	This course explores the fundamental principles and applications of surfaces, interfaces, and thin-film materials in engineering. Topics include surface energy, adsorption, wetting, interface phenomena, thin-film growth techniques, characterization methods, and the influence of surfaces and interfaces on material properties. Emphasis is placed on understanding how surface and interface behavior affects mechanical, thermal, optical, and electronic properties, with applications in coatings, microelectronics, nanomaterials, and advanced materials engineering.		
<b>PREREQUISITES</b>	This course builds on foundational knowledge of materials science, solid-state physics, and chemistry. Students are expected to have an understanding of crystal structures, bonding, thermodynamics, and basic materials characterization techniques. Familiarity with thin-film deposition methods and surface analysis tools is helpful but not required, as the course introduces these concepts in the context of surface and interface phenomena.		
<b>TEACHING AND EXAMINATION METHODS</b>	Lectures, Homework assignments, Quizzes, Midterm examination, Final exam		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes.		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	Students will understand the principles of surfaces, interfaces, and thin films, analyze thin-film growth and deposition techniques, and apply this knowledge to predict material behavior. They will also evaluate surface and thin-film properties using characterization methods and relate these phenomena to engineering applications in coatings, microelectronics, and advanced materials.
<b>General Skills</b>	Students will develop analytical and problem-solving skills, interpret surface and thin-film behavior, and apply theoretical and experimental methods to materials engineering challenges. They will

	also gain technical proficiency and the ability to communicate scientific results effectively.
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### 3. COURSE CONTENT

The course covers fundamental concepts of surfaces, interfaces, and thin-film materials, including surface energy, adsorption, wetting, and interfacial phenomena. Students will study thin-film growth mechanisms, deposition techniques, and characterization methods, and explore how surfaces and interfaces influence mechanical, thermal, optical, and electronic properties. Applications in coatings, microelectronics, and nanostructured materials are emphasized throughout.

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face.												
<b>Use of ICT</b>	<p>ICT plays a significant role in enhancing teaching, learning, experimentation, visualization, and assessment in this course as follows:</p> <p><b>Computational Tools for Problem Solving:</b> Spreadsheet calculations (Excel, Google Sheets), Coding solutions in Python, MATLAB, or Mathematica</p> <p><b>Online Learning Platforms:</b> Learning management systems (LMS) like Moodle, Online lectures, video tutorials, and animations,</p> <p><b>Communication and Collaboration:</b> Online discussion forums, Collaborative documents, Sharing of data and reports</p> <p><b>Presentation and Reporting Tools:</b> Lab reports (word processors), Data plots and charts (graphing tools), Presentations (PowerPoint, Google Slides).</p>												
<b>Teaching organization</b>	<p>The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 60%;">Activity</th> <th style="width: 40%;">Workload/semester (hours)</th> </tr> </thead> <tbody> <tr> <td>Lectures</td> <td style="text-align: center;">52</td> </tr> <tr> <td>self-study, quizzes, on-line tests</td> <td style="text-align: center;">46</td> </tr> <tr> <td>Independent study</td> <td style="text-align: center;">50</td> </tr> <tr> <td>Final written exam</td> <td style="text-align: center;">2</td> </tr> <tr> <td><b>Total</b></td> <td style="text-align: center;"><b>150</b></td> </tr> </tbody> </table>	Activity	Workload/semester (hours)	Lectures	52	self-study, quizzes, on-line tests	46	Independent study	50	Final written exam	2	<b>Total</b>	<b>150</b>
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<b>Total</b>	<b>150</b>												
<b>Student evaluation</b>	<p>Assessment Language: English</p> <ul style="list-style-type: none"> <li>Assessment Methods: Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Written Exams</li> </ul>												

### 5. SUGGESTED BIBLIOGRAPHY

#### Course Bibliography

Solid Surfaces, Interfaces and Thin Films Textbook | ISBN 978-3-319-10755-4 | Springer 2015

#### Additional bibliography for study

Handbook of Surfaces and Interfaces of Materials | ISBN 978-0-12-513910-6 | Academic Press 2001

## Nanomaterials and Nanotechnologies

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	MSEN 722	<b>SEMESTER</b>	7th Semester
<b>COURSE TITLE</b>	<b>Nanomaterials and Nanotechnologies</b>		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		4 (3L + 1T)	6
<b>COURSE TYPE</b>	Scientific area / Skill development		
<b>PREREQUISITES</b>			
<b>TEACHING AND EXAMINATION METHODS</b>	Lectures and tutorials; analysis of powder characterization data; final written exam and a short technical report.		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p>Upon successful completion of the course, undergraduate students will be able to:</p> <ul style="list-style-type: none"> <li>• Describe the fundamental concepts and characteristics of nanomaterials.</li> <li>• Identify common types of nanomaterials, including nanoparticles, nanowires, nanotubes, and nanostructured thin films.</li> <li>• Explain how size and nanoscale structure influence physical, chemical, mechanical, and electronic properties.</li> <li>• Understand basic synthesis, fabrication, and characterization methods for nanomaterials.</li> <li>• Recognize key applications of nanomaterials in electronics, energy, catalysis, biomedical devices, and advanced coatings.</li> <li>• Relate nanoscale phenomena to the performance of simple functional devices and systems.</li> </ul>
<b>General Skills</b>	<ul style="list-style-type: none"> <li>• Experimental data interpretation and reporting</li> <li>• Quantitative reasoning on process parameters</li> </ul>

	<ul style="list-style-type: none"> <li>• Awareness of industrial constraints and quality assurance</li> <li>• Independent learning from standards and technical literature</li> </ul>
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### 3. COURSE CONTENT

This course provides a comprehensive introduction to the science, properties, and applications of nanomaterials. Topics include the synthesis, structure, and characterization of nanoparticles, nanowires, nanotubes, and thin nanostructured films. Students explore size-dependent physical, chemical, mechanical, and electronic properties, as well as the principles underlying quantum effects at the nanoscale. The course also covers fabrication techniques, self-assembly, and integration of nanomaterials into functional devices and systems. Applications in electronics, energy storage and conversion, catalysis, biomedical devices, and advanced coatings are emphasized throughout.

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face.																
<b>Use of ICT</b>	<p>ICT will be used in teaching the course, and in communication with students:</p> <ul style="list-style-type: none"> <li>• teaching of the course with modern distance learning (ZOOM) and asynchronous education tools via elearning platform of AUTH,</li> </ul> <p>communication with students via email, ZOOM, and elearning platform of AUTH.</p>																
<b>Teaching organization</b>	<p>The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).</p> <table border="1" data-bbox="523 1308 1337 1585"> <thead> <tr> <th>Activity</th> <th>Workload/semester (hours)</th> </tr> </thead> <tbody> <tr> <td>Lectures</td> <td>39</td> </tr> <tr> <td>Tutorials / problem sessions</td> <td>13</td> </tr> <tr> <td>Data analysis / short report</td> <td>16</td> </tr> <tr> <td>Independent study</td> <td>64</td> </tr> <tr> <td>Exam preparation</td> <td>16</td> </tr> <tr> <td>Final written exam</td> <td>2</td> </tr> <tr> <td><b>Total</b></td> <td><b>150</b></td> </tr> </tbody> </table>	Activity	Workload/semester (hours)	Lectures	39	Tutorials / problem sessions	13	Data analysis / short report	16	Independent study	64	Exam preparation	16	Final written exam	2	<b>Total</b>	<b>150</b>
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<b>Student evaluation</b>	<p>Assessment language: English.            Methods: written final exam (60%), technical report/data-analysis assignment (25%), quizzes/problem sets (15%). Students are informed via the course guide and e-learning announcements.</p>																

### 5. SUGGESTED BIBLIOGRAPHY

#### EUDOXUS

To be specified in EUDOXUS.

#### Additional bibliography for study

- Teaching material slides

## Βασικές Αρχές Ημιαγωγικών Υλικών

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	<b>MSEN 723</b>	<b>SEMESTER</b>	7 <sup>th</sup> Semester
<b>COURSE TITLE</b>	<b>Fundamentals of Semiconductor Materials</b>		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		4	6
<b>COURSE TYPE</b>	The course covers the structure, electronic properties, and defects of semiconductors, including doping, charge carriers, band theory, and transport phenomena. Students learn characterization techniques and explore practical applications in devices such as diodes, transistors, LEDs, and solar cells, linking atomic- and micro-scale phenomena to device performance.		
<b>PREREQUISITES</b>	Students are expected to have a foundation in: <ul style="list-style-type: none"> <li>● <b>Physics:</b> Basic solid-state physics, electricity, and magnetism.</li> <li>● <b>Materials Science:</b> Crystal structures, bonding, and basic material properties.</li> <li>● <b>Mathematics:</b> Calculus and linear algebra for analyzing electronic and thermal behavior.</li> </ul> <b>Chemistry:</b> Atomic structure, chemical bonding, and periodic table concepts.		
<b>TEACHING AND EXAMINATION METHODS</b>	Lectures, Homework assignments, Quizzes, Midterm examination, Final exam		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes.		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	Upon completing the course, students will be able to: <ol style="list-style-type: none"> <li>1. Explain the structure, electronic properties, and behavior of semiconductor materials.</li> <li>2. Analyze the effects of defects, doping, and impurities on material properties.</li> <li>3. Relate atomic- and micro-scale phenomena to the performance of semiconductor devices.</li> <li>4. Apply characterization techniques to assess semiconductor material properties.</li> <li>5. Connect semiconductor material fundamentals to practical engineering applications.</li> </ol>
<b>General Skills</b>	Upon completing this course, students will develop the following skills:

	<ol style="list-style-type: none"> <li>1. Analytical Thinking: Ability to relate semiconductor structure and composition to electronic and optical properties.</li> <li>2. Problem-Solving: Analyze the effects of doping, defects, and impurities on semiconductor behavior.</li> <li>3. Experimental and Data Analysis Skills: Conduct and interpret characterization techniques for semiconductor materials.</li> <li>4. Technical Proficiency: Use computational and laboratory tools to model, simulate, and analyze semiconductors.</li> <li>5. Engineering Application: Translate material understanding into practical device design and performance evaluation.</li> <li>6. Communication Skills: Present scientific findings clearly in written, graphical, and oral formats.</li> </ol>
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### 3. COURSE CONTENT

This course covers the structure, electronic properties, defects, and doping of semiconductor materials. Students will learn about charge carriers, band theory, transport phenomena, and characterization techniques, and explore applications in electronic and optoelectronic devices such as diodes, transistors, LEDs, and solar cells. Emphasis is placed on linking atomic- and micro-scale material behavior to device performance.

#### Course Content

1. **Introduction to Semiconductors:** Overview of semiconductors and their role in materials engineering | Classification: intrinsic and extrinsic semiconductors
2. **Crystal Structure:** Diamond and zinc blende structures | Unit cells, lattice parameters, and symmetry | defects, impurities and their effects
3. **Electronic Structure and Band Theory:** Energy bands and band gaps | Fermi level and carrier concentration | Direct and indirect bandgap materials
4. **Charge Carriers and Doping:** Electrons, holes, and carrier mobility | n-type and p-type doping | Carrier generation, recombination, and transport
5. **Electrical and Optical Properties:** Electrical conductivity and resistivity | Optical absorption, emission, and photoconductivity | Semiconductor heterostructures
6. **Characterization Techniques:** Hall effect measurements | Electrical and optical characterization methods | Surface and interface analysis
7. **Applications:** Devices: diodes, transistors, and LEDs | Solar cells and optoelectronic devices | Microelectronics and nanostructured semiconductors

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face.
<b>Use of ICT</b>	<p>ICT plays a significant role in enhancing teaching, learning, experimentation, visualization, and assessment in this course as follows:</p> <p><b>Computational Tools for Problem Solving:</b> Spreadsheet calculations (Excel, Google Sheets), Coding solutions in Python, MATLAB, or Mathematica</p> <p><b>Online Learning Platforms:</b> Learning management systems (LMS) like Moodle, Online lectures, video tutorials, and animations,</p> <p><b>Communication and Collaboration:</b> Online discussion forums, Collaborative documents, Sharing of data and reports</p> <p><b>Presentation and Reporting Tools:</b> Lab reports (word processors), Data plots and charts (graphing tools), Presentations (PowerPoint, Google Slides).</p>
<b>Teaching organization</b>	The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).

	Activity	Workload/semester (hours)
	Lectures	52
	self-study, quizzes, on-line tests	46
	Independent study	50
	Final written exam	2
	<b>Total</b>	<b>150</b>
<b>Student evaluation</b>	Assessment Language: English <ul style="list-style-type: none"> <li>Assessment Methods: Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Written Exams</li> </ul>	

## 5. SUGGESTED BIBLIOGRAPHY

### Course Bibliography

Fundamentals of Semiconductor Materials and Devices | ISBN 978-1-119-89142-0 | Wiley 2024

### Additional bibliography for study

Fundamentals of Semiconductors | ISBN 978-3-642-00709-5 | Springer 2010

## Bio organic materials

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	<b>MSEN 731</b>	<b>SEMESTER</b>	7 <sup>th</sup> Semester
<b>COURSE TITLE</b>	<b>Bioorganic Materials</b>		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		4	6
<b>COURSE TYPE</b>	Scientific Area		
<b>PREREQUISITES</b>	No prerequisites		
<b>TEACHING AND EXAMINATION METHODS</b>	English		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>			
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p>By the end of this course, students will be able to:</p> <ol style="list-style-type: none"> <li>1. Understand the organic chemistry of biomolecules.</li> <li>2. Realize how bioorganic materials interact with cells, tissues, and biomolecules</li> <li>3. Realize the noncovalent interactions and how they drive self-assembly</li> <li>4. Apply principles of organic chemistry and bioconjugation.</li> <li>5. Gain knowledge of bioorganic materials for drug delivery systems</li> <li>6. Understand the importance of biocompatibility and biodegradation</li> <li>7. Understand, and evaluate how biomaterials are built from organic and biological molecules</li> <li>8. Gain knowledge of applications of bioorganic materials in pharmaceuticals, materials science, and medical engineering</li> </ol>
<b>General Skills</b>	<ul style="list-style-type: none"> <li>• Searching, analyzing and synthesizing data and information, using the necessary technologies</li> <li>• Decision-making</li> <li>• Independent work</li> </ul>

	<ul style="list-style-type: none"> <li>• Teamwork</li> <li>• Generate new research ideas</li> <li>• Project planning and management emphasizing on the materials science</li> <li>• Promoting free, creative and inductive thinking</li> <li>• Modeling and solving real-world problems</li> <li>• Working in a multidisciplinary environment</li> </ul>
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### 3. COURSE CONTENT

1. Convergence of organic chemistry, biology, and materials science
2. Biomaterials and biological building blocks:
  - 2.1. Peptide and Protein-Based Materials and their applications
  - 2.2. DNA and Nucleic Acid based materials
  - 2.3. Carbohydrates and biomaterials based on polysaccharides
  - 2.4. Lipids and their derivatives
3. Organic synthesis for biomaterials or probes
4. Bioorganic materials for Diagnostics and Biosensors
5. Bioorganic materials for Drug Delivery Systems
6. Sustainable and biodegradable materials

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face.															
<b>Use of ICT</b>	Use of ICT in Course Teaching, Use of ICT in Communication with Students Description: Use of Information and Communication Technologies (ICT) in teaching the course with tools of modern distance learning (ZOOM) and asynchronous education (eclass). Use of learning aids based on ICT: Excel, Word, PowerPoint Use of ICT in student assessment: Electronic grading (eclass, univervis). <ul style="list-style-type: none"> <li>• Use of ICT in communication with students: eclass, email, ZOOM.</li> </ul>															
<b>Teaching organization</b>	The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards). <table border="1" data-bbox="523 1615 1200 1928"> <thead> <tr> <th>Activity</th> <th>Workload/semester (hours)</th> </tr> </thead> <tbody> <tr> <td>Lectures</td> <td>52</td> </tr> <tr> <td>Tutorials / problem sessions</td> <td>13</td> </tr> <tr> <td>Bibliographic Research and analysis</td> <td>69</td> </tr> <tr> <td>Writing of assignments</td> <td>13</td> </tr> <tr> <td>Final written exam</td> <td>3</td> </tr> <tr> <td><b>Total</b></td> <td><b>150</b></td> </tr> </tbody> </table>		Activity	Workload/semester (hours)	Lectures	52	Tutorials / problem sessions	13	Bibliographic Research and analysis	69	Writing of assignments	13	Final written exam	3	<b>Total</b>	<b>150</b>
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Lectures	52															
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Bibliographic Research and analysis	69															
Writing of assignments	13															
Final written exam	3															
<b>Total</b>	<b>150</b>															
<b>Student evaluation</b>	Assessment Language: English Assessment Methods: <ul style="list-style-type: none"> <li>• Short Answer Questions,</li> </ul>															

	<ul style="list-style-type: none"> <li>• Multiple Choice Test</li> <li>• Essay Development Questions,</li> <li>• Problem Solving,</li> <li>• Written exams</li> </ul>
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## 5. SUGGESTED BIBLIOGRAPHY

### Course Bibliography

Introduction to Bioorganic Chemistry and Chemical Biology by David Van Vranken, Gregory A Weiss, Garland Science, Publication Date 2012 ISBN-13: 978-0815342144

### Additional bibliography for study

Teaching material slides

## Biochemistry Theory and Laboratory

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	<b>MSEN 732</b>	<b>SEMESTER</b>	7 <sup>th</sup> Semester
<b>COURSE TITLE</b>	<b>Biochemistry Theory and Laboratory</b>		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		Lectures: 4 theory & 2 lab	6
<b>COURSE TYPE</b>	Background and Scientific Area		
<b>PREREQUISITES</b>	No prerequisites		
<b>TEACHING AND EXAMINATION METHODS</b>	English		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>			
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p>By the end of this course, students will:</p> <ul style="list-style-type: none"> <li>• understand the structure and function of proteins and enzymes, hence the functioning of living organisms at the molecular level</li> <li>• gain basic knowledge of the nucleic acids (DNA, RNA), the biosynthesis of nucleic acids and their catabolism</li> <li>• learn the genetic code that governs all living organisms</li> <li>• understand the mechanism of protein synthesis and how it is regulated</li> <li>• learn the covalent modifications of proteins and its formation in higher configurations</li> <li>• know the technology of recombinant DNA and its applications.</li> </ul>
<b>General Skills</b>	<ul style="list-style-type: none"> <li>• Searching, analyzing and synthesizing data and information</li> <li>• Decision-making</li> <li>• Independent work</li> <li>• Teamwork</li> <li>• Generate new research ideas</li> </ul>

	<ul style="list-style-type: none"> <li>• Project planning and management emphasizing materials science</li> <li>• Promoting free, creative and inductive thinking</li> <li>• Modeling and solving real-world problems</li> <li>• Working in a multidisciplinary environment</li> </ul>
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### 3. COURSE CONTENT

#### **Biochemistry Theory**

1. Water (physical properties and hydrogen bonding of water, structure of liquid water, the ion product of water: the pH scale, acids and bases, the fitness of the aqueous environment for living organisms).
2. Amino acids and Proteins  
Acid- base properties of amino acids, the amino acids as building blocks of proteins, common amino acids, rare amino acids, non-protein amino acids. The stereochemistry of amino acids and the absorption spectra. Amino acid reactions of amino groups, carboxyl groups and residue groups. Classification of proteins, Protein structure (covalent backbone and amino acid sequence, peptides, primary, secondary, tertiary, quaternary structure, higher conformation of proteins). Biological role of proteins, structural and functional proteins, protein denaturation, structure function relationship of proteins.
3. Enzymes  
Naming and classification of enzymes, Kinetics, enzyme cofactors, coenzymes, cytochromes, inhibition of enzymic reactions, enzymic specificity, enzyme substrate complexes and covalent enzyme-substrate compounds, enzyme function regulation, isoenzymes
4. Nucleic acids  
Nucleic acids and primary structure. Secondary structure of nucleic acids, DNA, RNA properties in solution, the biosynthesis of nucleotides, nucleic acid catabolism. Recombinant DNA, DNA replication, transcription and repair.
5. Protein synthesis  
The genetic code, the mechanism of protein synthesis, regulation of protein synthesis, covalent modifications, higher conformational structures of proteins and subcellular localization.
6. Cellular defense against viral components.
7. Recombinant DNA technology.

#### **Biochemistry Laboratory**

1. Quantitative determination of proteins

2. Study of protein properties (isoelectric point, protein stability, denaturation etc.)
3. Protein purification
4. Protein electrophoresis
5. Enzyme Kinetics, measurement of enzyme reaction rates using spectrophotometry
6. Michaelis–Menten analysis and calculation of  $V_{max}$  and  $K_m$
7. Study of enzyme inhibitors (competitive, non-competitive)
8. Effect of pH and temperature on enzyme activity
9. Isolation of genomic and plasmid DNA
10. Quality and quantity assessment via spectrophotometry and agarose gel electrophoresis
11. Amplification of a specific DNA fragment using Polymerase Chain Reaction (PCR)
12. Analysis of PCR products by agarose gel electrophoresis
13. Restriction digestion of DNA with specific endonucleases

DNA ligation and *Escherichia coli* transformation

4. LEARNING & TEACHING METHODS – EVALUATION																	
<b>Teaching method</b>	Face-to-face.																
<b>Use of ICT</b>	<p>Use of ICT in Course Teaching, Use of ICT in Communication with Students</p> <p>Description: Use of Information and Communication Technologies (ICT) in teaching the course with tools of modern distance learning (ZOOM) and asynchronous education (eclass).</p> <p>Use of learning aids based on ICT: Excel, Word, Power Point</p> <p>Use of ICT in student assessment: Electronic grading (eclass, univervis).</p> <p>Use of ICT in communication with students: eclass, email, ZOOM.</p>																
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Activity	Workload/semester (hours)																
Lectures	28																
Tutorials / problem sessions	14																
Bibliographic Research and analysis	74																
Laboratory exercises	24																
Writing of assignments	8																
Final written exam	2																
<b>Total</b>	<b>150</b>																
<b>Student evaluation</b>	<p>Assessment Language: English</p> <p>Assessment Methods:</p> <ul style="list-style-type: none"> <li>• Short Answer Questions,</li> <li>• Multiple Choice Test</li> <li>• Essay Development Questions,</li> <li>• Problem Solving,</li> </ul>																

- Written exams

## 5. SUGGESTED BIBLIOGRAPHY

### Course Bibliography

Lehninger Principles of Biochemistry, David L. Nelson and Michael M. Cox (8<sup>th</sup> Edition).  
ISBN: 9781319381493

Voet's Principles of Biochemistry, Donald Voet, Judith G. Voet, Charlotte W. Pratt  
(Global Edition, 5th Edition). ISBN: 9781119455134

### Additional bibliography for study

Teaching material slides

## Bioinorganic Materials

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	<b>MSEN 734</b>	<b>SEMESTER</b>	7 <sup>th</sup> Semester
<b>COURSE TITLE</b>	<b>Bioinorganic Materials</b>		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		Lectures: 3 Tutorial: 1 Total: 4	6
<b>COURSE TYPE</b>	Scientific Area, Skill Development		
<b>PREREQUISITES</b>	No prerequisites		
<b>TEACHING AND EXAMINATION METHODS</b>	English		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>			
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p>By the end of this course, students are expected to:</p> <ul style="list-style-type: none"> <li>• be aware of the role of the trace elements</li> <li>• be aware of the role of the metals in life and as drugs</li> <li>• know some important metalloproteins and their significance.</li> <li>• be aware of applications of inorganic nanoparticles of biological interest.</li> <li>• be up to date on technological and medical applications of inorganic nanoparticles.</li> <li>• get to know inorganic nanoscale materials, their synthetic approaches and characterization techniques.</li> <li>• get to know post-synthetic approaches for functional inorganic-based nanoarchitectures materials for biomedical applications.</li> </ul>
<b>General Skills</b>	<p>By the end of this course, students will be:</p> <ul style="list-style-type: none"> <li>• familiar with trace elements and their biological relevance.</li> <li>• familiar with functionalized inorganic-based nanoarchitectures.</li> </ul>

	<ul style="list-style-type: none"> <li>familiar with bioinorganic materials used for clinical and biomedical applications.</li> <li></li> </ul>
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### 3. COURSE CONTENT

- Introduction to Bioinorganic Chemistry.
- Metalloproteins and their biological functions.
- Metals and inorganic compounds in biological systems.
- Metal-based drugs.
- Introduction to the properties of Inorganic-based materials at the nanoscale.
- Inorganic-based Nanomedicine and Nanopharmaceuticals.
- Functionality of Inorganic-based nanoarchitectures and chemical modifications.
- Magnetic nanoparticles for therapy and diagnosis: Drug carriers, hyperthermia, magnetomechanical induction, contrast agents in MRI and PET.
- Inorganic Nanoparticles as antimicrobial, photodynamic agents.

### 4. LEARNING & TEACHING METHODS – EVALUATION

<b>Teaching method</b>	Face-to-face.														
<b>Use of ICT</b>	<p>Use of ICT in Course Teaching, Use of ICT in Communication with Students</p> <p>Description: Use of Information and Communication Technologies (ICT) in teaching the course with tools of modern distance learning (ZOOM) and asynchronous education (eclass).</p> <p>Use of learning aids based on ICT: Excel, Word, Power Point</p> <p>Use of ICT in student assessment: Electronic grading (eclass, universis).</p> <p>Use of ICT in communication with students: eclass, email, ZOOM.</p>														
<b>Teaching organization</b>	<p>The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).</p> <table border="1" data-bbox="523 1550 1200 1868"> <thead> <tr> <th>Activity</th> <th>Workload/semester (hours)</th> </tr> </thead> <tbody> <tr> <td>Lectures</td> <td>39</td> </tr> <tr> <td>Tutorials / problem sessions</td> <td>13</td> </tr> <tr> <td>Bibliographic Research and analysis</td> <td>55</td> </tr> <tr> <td>Writing of assignments</td> <td>40</td> </tr> <tr> <td>Final written exam</td> <td>3</td> </tr> <tr> <td><b>Total</b></td> <td><b>150</b></td> </tr> </tbody> </table>	Activity	Workload/semester (hours)	Lectures	39	Tutorials / problem sessions	13	Bibliographic Research and analysis	55	Writing of assignments	40	Final written exam	3	<b>Total</b>	<b>150</b>
Activity	Workload/semester (hours)														
Lectures	39														
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Bibliographic Research and analysis	55														
Writing of assignments	40														
Final written exam	3														
<b>Total</b>	<b>150</b>														
<b>Student evaluation</b>	<p>Assessment Language: English</p> <p>Assessment Methods:</p> <ul style="list-style-type: none"> <li>• Written exam with (a) short answer questions, (b) extended answer questions and (c) problem solving</li> </ul>														

- Presentation of Assignment.

## 5. SUGGESTED BIBLIOGRAPHY

### Course Bibliography

Robert R. Crichton, Biological Inorganic Chemistry: An Introduction, Third Edition, Academic Press, 2018  
Rosette M. Roat-Malone, Bioinorganic Chemistry: A Short Course, Third Edition, Wiley, 2020  
Xuan Wang, Sajid Bashir, Jingbo Louise Liu, Nanochemistry: From Theory to Application for In-Depth Understanding of Nanomaterials, De Gruyter GmbH, Berlin/Boston, 2023  
Zhyrgul Abdullaeva, Synthesis of Nanoparticles and Nanomaterials: Biological Approaches, Springer, 2017

### Additional bibliography for study

Professors' notes

## 8<sup>th</sup> Semester

### CAD CAE in materials engineering

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	<b>MSEN 801</b>	<b>SEMESTER</b>	8 <sup>th</sup> Semester
<b>COURSE TITLE</b>	<b>CAD CAE in materials engineering</b>		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		4 (3L + 1T)	6
<b>COURSE TYPE</b>	Scientific area / Skills development		
<b>PREREQUISITES</b>	Introduction to Solid Mechanics, Design and Analysis of Materials Experiments		
<b>TEACHING AND EXAMINATION METHODS</b>	Face-to-face		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p>By the end of this course, students will be able to:</p> <ul style="list-style-type: none"> <li>• Understand the theory and limitations of Finite Element Method</li> <li>• Create accurate Computer Aided Engineering (CAE) models</li> <li>• Handle modern commercial CAE software for pre- and post-processing</li> <li>• Understand and Evaluate analysis results</li> </ul>
<b>General Skills</b>	<ul style="list-style-type: none"> <li>• Search for, analysis and synthesis of data and information, with the use of the necessary technology</li> <li>• Work in an international context</li> <li>• Advance free, creative and causative thinking</li> <li>• Work in teams</li> <li>• Decision-making</li> <li>• Modeling and solving real-world problems</li> <li>• Working in a multidisciplinary environment</li> <li>• Generate new research ideas</li> </ul>

### 3. COURSE CONTENT

This course bridges the gap between material science theory and computational mechanics, introducing students to the practical application of the Finite Element Method (FEM) in engineering design. Moving beyond simple geometric modeling, students will learn to translate physical problems into accurate Computer-Aided Engineering (CAE) models. The curriculum emphasizes the theoretical foundations and inherent limitations of numerical simulation.

Key topics:

- Fundamentals of Finite Element Theory
- Advanced Pre-processing & Material Modeling.
- Simulation Setup and Boundary Conditions
- Result Interpretation and Validation

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face.																
<b>Use of ICT</b>	Use of ICT in Course Teaching, Use of ICT in Communication with Students Description: Use of Information and Communication Technologies (ICT) in teaching the course with tools of modern distance learning (MS-Teams) and asynchronous education (e-learning). Use of learning aids based on ICT: Excel, Matlab, CAE software Use of ICT in student assessment: Electronic grading (e-learning). Use of ICT in communication with students: e-learning, email, MS-Teams.																
<b>Teaching organization</b>	The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards). <table border="1" data-bbox="523 1205 1337 1482"> <thead> <tr> <th>Activity</th> <th>Workload/semester (hours)</th> </tr> </thead> <tbody> <tr> <td>Lectures</td> <td>39</td> </tr> <tr> <td>Tutorials / problem sessions</td> <td>13</td> </tr> <tr> <td>Short assignments / quizzes</td> <td>10</td> </tr> <tr> <td>Independent study</td> <td>70</td> </tr> <tr> <td>Exam preparation</td> <td>16</td> </tr> <tr> <td>Final written exam</td> <td>2</td> </tr> <tr> <td><b>Total</b></td> <td><b>150</b></td> </tr> </tbody> </table>	Activity	Workload/semester (hours)	Lectures	39	Tutorials / problem sessions	13	Short assignments / quizzes	10	Independent study	70	Exam preparation	16	Final written exam	2	<b>Total</b>	<b>150</b>
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Final written exam	2																
<b>Total</b>	<b>150</b>																
<b>Student evaluation</b>	Report Oral exams Written Exams with Problem Solving (Summative)																

### 5. SUGGESTED BIBLIOGRAPHY

#### EUDOXUS

To be specified in EUDOXUS.

#### Additional bibliography for study

- Daryl L. Logan. (2017). A First Course in the Finite Element Method (6<sup>th</sup> Edition). Cengage Learning.

## Deformation and failure of engineering materials

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	<b>MSEN 802</b>	<b>SEMESTER</b>	8 <sup>th</sup> Semester
<b>COURSE TITLE</b>	<b>Deformation and failure of engineering materials</b>		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		4 (3L + 1T)	6
<b>COURSE TYPE</b>	Scientific area / Skills development		
<b>PREREQUISITES</b>	Introduction to Solid Mechanics, Design and Analysis of Materials Experiments, Mechanical Behavior of Engineering Materials		
<b>TEACHING AND EXAMINATION METHODS</b>	Face-to-face		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p>By the end of this course, students will be able to:</p> <ul style="list-style-type: none"> <li>• Differentiate between the fundamental mechanisms of material deformation</li> <li>• Analyze the physics of fatigue crack nucleation and propagation, identifying microstructural features that influence fatigue life</li> <li>• Predict the fatigue life of engineering components</li> <li>• Evaluate the impact of variable amplitude loading and mean stress effects on component durability</li> </ul>
<b>General Skills</b>	<ul style="list-style-type: none"> <li>• Search for, analysis and synthesis of data and information, with the use of the necessary technology</li> <li>• Work in an international context</li> <li>• Advance free, creative and causative thinking</li> <li>• Work in teams</li> <li>• Decision-making</li> <li>• Modeling and solving real-world problems</li> <li>• Working in a multidisciplinary environment</li> <li>• Generate new research ideas</li> </ul>

### 3. COURSE CONTENT

This course provides an insight into the mechanical response of engineering materials, with a primary focus on cyclic loading and fatigue failure, while foundational topics in plastic deformation and static fracture are covered. The course bridges theory and application, equipping students with the analytical tools to predict component life. Emphasis is placed on modern approaches to fatigue design, including fracture mechanics and strain-based methods used in the automotive and aerospace industries.

Key topics:

- Plastic Deformation & Static Failure
- High-Cycle Fatigue.
- Low-Cycle Fatigue
- Fracture Mechanics & Crack Growth
- Variable Loading & Failure Analysis

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face.	
<b>Use of ICT</b>	Use of ICT in Course Teaching, Use of ICT in Communication with Students Description: Use of Information and Communication Technologies (ICT) in teaching the course with tools of modern distance learning (MS-Teams) and asynchronous education (e-learning). Use of learning aids based on ICT: Excel, Matlab, CAE software Use of ICT in student assessment: Electronic grading (e-learning). Use of ICT in communication with students: e-learning, email, MS-Teams.	
<b>Teaching organization</b>	The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).	
	<b>Activity</b>	<b>Workload/semester (hours)</b>
	Lectures	39
	Tutorials / problem sessions	13
	Short assignments / quizzes	10
	Independent study	70
	Exam preparation	16
	Final written exam	2
	<b>Total</b>	<b>150</b>
<b>Student evaluation</b>	Report Oral exams Written Exams with Problem Solving (Summative)	

### 5. SUGGESTED BIBLIOGRAPHY

#### EUDOXUS

To be specified in EUDOXUS.

#### Additional bibliography for study

1. Lee, Y-L., Pan, J., Hathaway, R. B., Barkey, M. E. (2005). Fatigue Testing and Analysis: Theory and Practice (1<sup>st</sup> Edition). Butterworth-Heinemann.
2. Schijve, J. (2009). Fatigue of Structures and Materials (2<sup>nd</sup> Edition). Springer Dordrecht

## Solidification, Casting and Welding

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	MSEN 811	<b>SEMESTER</b>	8th Semester
<b>COURSE TITLE</b>	<b>Solidification, Casting and Welding</b>		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		4 (3L + 1Lab/Demo)	6
<b>COURSE TYPE</b>	Scientific area / Skill development		
<b>PREREQUISITES</b>	Thermodynamics; Introduction to Materials Science and Engineering; Phase diagrams basics.		
<b>TEACHING AND EXAMINATION METHODS</b>	Lectures with demonstrations; problem-solving; lab-style assignments on defects and microstructure; final written exam.		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes (taught in English, subject to minimum enrollment).		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<ul style="list-style-type: none"> <li>• Relate solidification conditions to microstructure evolution (grain structure, segregation, dendrites).</li> <li>• Explain casting process families and select suitable routes based on geometry, alloy, and quality requirements.</li> <li>• Identify common casting defects and propose preventive and corrective actions.</li> <li>• Describe the fundamentals of welding processes and heat-affected zones and link them to microstructure and properties.</li> <li>• Assess residual stresses, distortion, and cracking risks in cast/welded components.</li> <li>• Apply basic process-selection and quality-control reasoning for industrial components.</li> </ul>
<b>General Skills</b>	<ul style="list-style-type: none"> <li>• Process understanding linked to microstructure and performance</li> <li>• Problem solving using simplified heat-transfer and solidification concepts</li> <li>• Quality mindset: defects, inspection, and standards awareness</li> </ul>

	<ul style="list-style-type: none"> <li>• Technical reporting based on case studies</li> </ul>
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### 3. COURSE CONTENT

- Solidification fundamentals: nucleation, growth, thermal gradients, cooling rates.
- Segregation and constitutional supercooling; dendritic structures; grain refinement.
- Casting processes: sand, investment, die casting, continuous casting; gating and risering concepts.
- Solidification defects: porosity, shrinkage, hot tearing; defect prevention strategies.
- Microstructure control through alloying, inoculation, and heat treatment (overview).
- Welding fundamentals: energy sources and key processes (arc, resistance, laser) (overview).
- Weld metallurgy: fusion zone and heat-affected zone; solidification cracking and transformations.
- Residual stresses, distortion, and welding defects; inspection and quality assurance overview.
- Case studies linking processing to component failure and reliability.

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face. Lectures, demonstrations, guided problem sessions, and case-study-based assignments.																
<b>Use of ICT</b>	E-learning for notes; video demonstrations; basic process simulation/visualization datasets (where available); spreadsheets for simplified solidification calculations.																
<b>Teaching organization</b>	<p>The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 70%;">Activity</th> <th style="width: 30%;">Workload/semester (hours)</th> </tr> </thead> <tbody> <tr> <td>Lectures</td> <td style="text-align: center;">39</td> </tr> <tr> <td>Laboratory demonstrations / tutorials</td> <td style="text-align: center;">13</td> </tr> <tr> <td>Case-study assignment / report</td> <td style="text-align: center;">16</td> </tr> <tr> <td>Independent study</td> <td style="text-align: center;">64</td> </tr> <tr> <td>Exam preparation</td> <td style="text-align: center;">16</td> </tr> <tr> <td>Final written exam</td> <td style="text-align: center;">2</td> </tr> <tr> <td><b>Total</b></td> <td style="text-align: center;"><b>150</b></td> </tr> </tbody> </table>	Activity	Workload/semester (hours)	Lectures	39	Laboratory demonstrations / tutorials	13	Case-study assignment / report	16	Independent study	64	Exam preparation	16	Final written exam	2	<b>Total</b>	<b>150</b>
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<b>Total</b>	<b>150</b>																
<b>Student evaluation</b>	<p>Assessment language: English.</p> <p>Methods: written final exam (60%), case-study assignment/report (25%), quizzes/problem sets (15%). Students are informed via the course guide and e-learning announcements.</p>																

### 5. SUGGESTED BIBLIOGRAPHY

#### EUDOXUS

To be specified in EUDOXUS.

#### Additional bibliography for study

- J. Campbell, Complete Casting Handbook.

- D.A. Porter, K.E. Easterling & M.Y. Sherif, Phase Transformations in Metals and Alloys (solidification sections).
- S. Kou, Welding Metallurgy.
- Selected course notes (indicative): MIT Materials Processing / Cambridge materials processing teaching materials.

## Waste Valorization and Advanced Recycling Technologies

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	MSEN 812	<b>SEMESTER</b>	8th Semester
<b>COURSE TITLE</b>	<b>Waste Valorization and Advanced Recycling Technologies</b>		
<b>TEACHING ACTIVITIES</b> Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>	
	4 (2L + 2Lab/Comp)	6	
<b>COURSE TYPE</b>	Scientific area / Skill development		
<b>PREREQUISITES</b>	Materials Circular Economy and LCA (recommended); basic Chemistry and Materials Science.		
<b>TEACHING AND EXAMINATION METHODS</b>	Lectures and case studies; lab/computer sessions on recycling flows and process routes; project-based assessment; final exam.		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes (taught in English, subject to minimum enrollment).		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<ul style="list-style-type: none"> <li>Describe valorization routes for key waste streams and their links to material cycles and quality.</li> <li>Differentiate mechanical, thermal, chemical, and bio-based recycling routes and identify applicability limits.</li> <li>Understand basic process flows for metals, polymers, glass, and electronic waste recycling.</li> <li>Evaluate trade-offs between recycling efficiency, product quality, energy use, and emissions.</li> <li>Recognize the role of policy, standards, and supply chains in enabling high-value recycling.</li> <li>Propose a recycling/valorization strategy for a selected waste stream supported by data and reasoning.</li> </ul>
<b>General Skills</b>	<ul style="list-style-type: none"> <li>Systems thinking across the value chain</li> <li>Data interpretation and scenario comparison</li> <li>Teamwork on multidisciplinary case studies</li> <li>Communication to technical and non-technical audiences</li> </ul>

### 3. COURSE CONTENT

- Waste streams and secondary raw materials: definitions, quality, and contamination issues.
- Mechanical recycling: sorting, size reduction, separation methods; polymer reprocessing limitations.
- Thermal and chemical recycling routes (overview) including depolymerization and solvent-based processes.
- Metals recycling: collection, shredding, pyrometallurgy and hydrometallurgy basics (overview).
- E-waste and battery recycling: critical material recovery concepts (overview).
- Construction and demolition waste; glass and ceramics recycling (overview).
- Waste-to-materials pathways: upcycling, composites, fillers, and circular product design links.
- Techno-economic and environmental assessment links (integration with LCA concepts).
- Case studies and a team project on a selected waste valorization pathway.

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face. Lectures, computer/workshop sessions, and project-based learning with case studies.																
<b>Use of ICT</b>	Computer labs using datasets (material flow, recycling rates) and simple modelling tools; e-learning for resources; collaborative tools for group project development.																
<b>Teaching organization</b>	<p>The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).</p> <table border="1"> <thead> <tr> <th>Activity</th> <th>Workload/semester (hours)</th> </tr> </thead> <tbody> <tr> <td>Lectures</td> <td>26</td> </tr> <tr> <td>Computer labs / workshops</td> <td>26</td> </tr> <tr> <td>Team project and report</td> <td>30</td> </tr> <tr> <td>Independent study</td> <td>50</td> </tr> <tr> <td>Exam preparation</td> <td>16</td> </tr> <tr> <td>Final written exam</td> <td>2</td> </tr> <tr> <td><b>Total</b></td> <td><b>150</b></td> </tr> </tbody> </table>	Activity	Workload/semester (hours)	Lectures	26	Computer labs / workshops	26	Team project and report	30	Independent study	50	Exam preparation	16	Final written exam	2	<b>Total</b>	<b>150</b>
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Independent study	50																
Exam preparation	16																
Final written exam	2																
<b>Total</b>	<b>150</b>																
<b>Student evaluation</b>	<p>Assessment language: English.</p> <p>Methods: team project/report and presentation (45%), written final exam (35%), quizzes/short assignments (20%). Students are informed via the course guide and e-learning announcements.</p>																

### 5. SUGGESTED BIBLIOGRAPHY

#### EUDOXUS

To be specified in EUDOXUS.

#### Additional bibliography for study

- Relevant review papers and reports on recycling technologies (provided by the instructor).
- EU/JRC and international guidance documents on waste management and recycling (selected).
- Selected materials flow and circular economy references (indicative): TU Delft waste and critical materials learning materials.

- Handbook chapters on metals and polymer recycling (selected).

## Critical raw materials

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	MSEN 813	<b>SEMESTER</b>	8th Semester
<b>COURSE TITLE</b>	<b>Critical raw materials</b>		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		4 (3L + 1T)	6
<b>COURSE TYPE</b>	Scientific area / General knowledge		
<b>PREREQUISITES</b>	Basic Chemistry and Materials Science. Recommended: Materials Circular Economy and LCA.		
<b>TEACHING AND EXAMINATION METHODS</b>	Lectures and tutorials; case studies on supply risk and substitution; final written exam and short policy/technical brief.		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes (taught in English, subject to minimum enrollment).		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<ul style="list-style-type: none"> <li>Define 'critical raw materials' and explain criticality drivers (economic importance, supply risk).</li> <li>Describe the raw-material value chain from exploration to processing, manufacturing, and end-of-life.</li> <li>Analyze major demand drivers (energy transition, electronics, mobility) and associated materials constraints.</li> <li>Evaluate strategies for criticality mitigation: substitution, efficiency, recycling, and diversification.</li> <li>Interpret basic indicators and datasets relevant to supply chains, geopolitics, and sustainability.</li> <li>Communicate evidence-based assessments of CRM-related risks and opportunities.</li> </ul>
<b>General Skills</b>	<ul style="list-style-type: none"> <li>Interdisciplinary reasoning (materials + economics + policy)</li> <li>Critical reading of reports and datasets</li> <li>Structured argumentation and brief writing</li> <li>Awareness of ethics and sustainability implications</li> </ul>

### 3. COURSE CONTENT

- Criticality concepts and assessment frameworks; key indicators and data sources.
- Raw materials value chain: mining, beneficiation, refining, materials production, manufacturing, use, end-of-life.
- Demand drivers and technology dependencies (batteries, magnets, photovoltaics, catalysts, semiconductors).
- Supply concentration, geopolitics, trade, and resilience concepts.
- Environmental and social aspects of raw materials extraction and processing (overview).
- Substitution and material efficiency strategies; design for reduced criticality.
- Recycling and urban mining; secondary supply and constraints.
- Policy and regulation overview (EU critical raw materials concepts; indicative global perspectives).
- Case studies and student briefs on selected critical materials.

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face. Lectures and guided discussions of case studies and datasets; short student presentations.																
<b>Use of ICT</b>	E-learning for resources; use of public datasets and dashboards (where available); spreadsheets for simple criticality indicator calculations and visualization.																
<b>Teaching organization</b>	<p>The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).</p> <table border="1"> <thead> <tr> <th>Activity</th> <th>Workload/semester (hours)</th> </tr> </thead> <tbody> <tr> <td>Lectures</td> <td>39</td> </tr> <tr> <td>Tutorials / seminars</td> <td>13</td> </tr> <tr> <td>Short brief / case study</td> <td>16</td> </tr> <tr> <td>Independent study</td> <td>64</td> </tr> <tr> <td>Exam preparation</td> <td>16</td> </tr> <tr> <td>Final written exam</td> <td>2</td> </tr> <tr> <td><b>Total</b></td> <td><b>150</b></td> </tr> </tbody> </table>	Activity	Workload/semester (hours)	Lectures	39	Tutorials / seminars	13	Short brief / case study	16	Independent study	64	Exam preparation	16	Final written exam	2	<b>Total</b>	<b>150</b>
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Final written exam	2																
<b>Total</b>	<b>150</b>																
<b>Student evaluation</b>	<p>Assessment language: English.</p> <p>Methods: written final exam (60%), individual short brief/report (25%), quizzes/participation (15%). Students are informed via the course guide and e-learning announcements.</p>																

### 5. SUGGESTED BIBLIOGRAPHY

#### EUDOXUS

To be specified in EUDOXUS.

#### Additional bibliography for study

- Selected EU and international reports on critical raw materials (updated annually/periodically).
- Academic review papers on criticality, supply chains, and substitution strategies.
- Selected online course materials (indicative): TU Delft / EIT RawMaterials learning resources.

## Optoelectronic and Sensors: Materials and Applications

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	MSEN 821	<b>SEMESTER</b>	8th Semester
<b>COURSE TITLE</b>	<b>Optoelectronic and Sensors: Materials and Applications</b>		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		4 (3L + 1T)	6
<b>COURSE TYPE</b>	Scientific area / Skill development		
<b>PREREQUISITES</b>			
<b>TEACHING AND EXAMINATION METHODS</b>	Lectures and tutorials; analysis of powder characterization data; final written exam and a short technical report.		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p>Upon successful completion of the course, undergraduate students will be able to:</p> <ul style="list-style-type: none"> <li>• Describe the basic principles of optoelectronic materials and devices.</li> <li>• Explain fundamental light–matter interactions in semiconductors and photonic materials.</li> <li>• Identify the operating principles of photodetectors, light-emitting devices, and optical sensors.</li> <li>• Understand basic mechanisms of signal transduction, sensitivity, and selectivity in optoelectronic sensors.</li> <li>• Recognize common materials characterization and fabrication methods used in optoelectronic devices.</li> <li>• Relate material properties to device performance in applications such as communications, imaging, healthcare, and wearable technologies.</li> </ul>
<b>General Skills</b>	<ul style="list-style-type: none"> <li>• Experimental data interpretation and reporting</li> <li>• Quantitative reasoning on process parameters</li> <li>• Awareness of industrial constraints and quality assurance</li> </ul>

	<ul style="list-style-type: none"> <li>Independent learning from standards and technical literature</li> </ul>
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### 3. COURSE CONTENT

This course provides a comprehensive introduction to the materials, principles, and applications of optoelectronic devices and sensors. Topics include semiconductors, photonic materials, light-matter interactions, and the design and operation of photodetectors, light-emitting devices, and optical sensors. Students explore the mechanisms of signal transduction, sensitivity, and selectivity, as well as methods for material characterization and device fabrication. Emphasis is placed on applications in communications, imaging, environmental monitoring, healthcare, and wearable technologies, highlighting how material properties influence device performance and functionality.

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face.																
<b>Use of ICT</b>	<p>ICT will be used in teaching the course, and in communication with students:</p> <ul style="list-style-type: none"> <li>teaching of the course with modern distance learning (ZOOM) and asynchronous education tools via elearning platform of AUTH,</li> </ul> <p>communication with students via email, ZOOM, and elearning platform of AUTH.</p>																
<b>Teaching organization</b>	<p>The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 70%;">Activity</th> <th style="width: 30%;">Workload/semester (hours)</th> </tr> </thead> <tbody> <tr> <td>Lectures</td> <td style="text-align: center;">39</td> </tr> <tr> <td>Tutorials / problem sessions</td> <td style="text-align: center;">13</td> </tr> <tr> <td>Data analysis / short report</td> <td style="text-align: center;">16</td> </tr> <tr> <td>Independent study</td> <td style="text-align: center;">64</td> </tr> <tr> <td>Exam preparation</td> <td style="text-align: center;">16</td> </tr> <tr> <td>Final written exam</td> <td style="text-align: center;">2</td> </tr> <tr> <td><b>Total</b></td> <td style="text-align: center;"><b>150</b></td> </tr> </tbody> </table>	Activity	Workload/semester (hours)	Lectures	39	Tutorials / problem sessions	13	Data analysis / short report	16	Independent study	64	Exam preparation	16	Final written exam	2	<b>Total</b>	<b>150</b>
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Tutorials / problem sessions	13																
Data analysis / short report	16																
Independent study	64																
Exam preparation	16																
Final written exam	2																
<b>Total</b>	<b>150</b>																
<b>Student evaluation</b>	<p>Assessment language: English.            Methods: written final exam (60%), technical report/data-analysis assignment (25%), quizzes/problem sets (15%). Students are informed via the course guide and e-learning announcements.</p>																

### 5. SUGGESTED BIBLIOGRAPHY

#### EUDOXUS

To be specified in EUDOXUS.

#### Additional bibliography for study

- Teaching material slides

## Materials and Systems in Energy Technologies

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	MSEN 822	<b>SEMESTER</b>	8th Semester
<b>COURSE TITLE</b>	<b>Materials and Systems in Energy Technologies</b>		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		4 (3L + 1T)	6
<b>COURSE TYPE</b>	Background / General Knowledge		
<b>PREREQUISITES</b>	none		
<b>TEACHING AND EXAMINATION METHODS</b>	Face – to – face lectures and guided problem-solving sessions; final written examination.		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p><b>Knowledge</b></p> <p>After successfully completing the course, students will be able to:</p> <ul style="list-style-type: none"> <li>• Explain how materials properties, microstructure and interfaces govern the performance of energy-related devices and systems.</li> <li>• Describe the roles of electrodes, electrolytes, separators and composite architectures in representative energy technologies such as batteries, electrochemical capacitors and fuel cells.</li> <li>• Understand transport phenomena (ionic, electronic, thermal and mass transport) in materials used within energy devices.</li> <li>• Interpret degradation mechanisms, aging processes and failure modes arising from materials selection and operating conditions.</li> <li>• Relate materials processing routes and interfacial design to efficiency, durability and reliability at the device and system level.</li> </ul> <p><b>Skills</b></p>

	<p>Upon completion, students will be able to:</p> <ul style="list-style-type: none"> <li>• Apply materials science principles to analyze structure-property-performance relationships in energy-related systems.</li> <li>• Evaluate materials selection criteria using performance metrics such as stability, conductivity, capacity and efficiency.</li> <li>• Perform basic characterization and performance assessment of materials and components within energy devices using laboratory measurements and diagnostic tools.</li> <li>• Analyze experimental data to identify materials-limited performance and degradation effects.</li> </ul> <p><b>Abilities / Competences</b> Students will develop the ability to:</p> <ul style="list-style-type: none"> <li>• Integrate materials science concepts across length scales to assess the behavior of materials in functional energy devices.</li> <li>• Assess trade-offs between materials properties, processing complexity and system-level performance.</li> <li>• Identify materials-driven limitations and opportunities for improving device durability and reliability.</li> <li>• Communicate materials-focused analyses and experimental findings clearly in written and oral formats.</li> <li>• Connect this course with advanced subjects such as functional materials, interfaces, corrosion, electrochemistry and materials characterization.</li> </ul>
<p><b>General Skills</b></p>	<ul style="list-style-type: none"> <li>• Practical application of knowledge</li> <li>• Search, analysis and synthesis of data and information</li> <li>• Autonomous work</li> <li>• Teamwork</li> <li>• Working in a multidisciplinary environment</li> </ul>

### 3. COURSE CONTENT

This course introduces materials-oriented principles underlying energy technologies, with emphasis on how material properties, interfaces and architectures govern the performance of functional devices and engineered systems. Building on concepts from electrochemical and materials science, students examine the role of electrodes, electrolytes, interfaces and composite structures in representative energy technologies such as batteries, electrochemical capacitors and fuel cells. The course highlights structure-property-performance relationships, materials selection criteria, transport

phenomena and degradation mechanisms relevant to materials used in energy-related applications. Attention is given to how processing routes, microstructure and interfacial design influence efficiency, durability and reliability at the device and subsystem level. Laboratory demonstrations focus on materials characterization and performance assessment within energy-related systems, including electrochemical response, stability metrics and diagnostic analysis. By the end of the course, students will understand how materials science principles enable the design, optimization and integration of materials into complex energy technologies.

#### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face.																
<b>Use of ICT</b>	<p>ICT will be used in teaching the course, and in communication with students:</p> <ul style="list-style-type: none"> <li>teaching of the course with modern distance learning (ZOOM) and asynchronous education tools via elearning platform of AUTH,</li> <li>communication with students via email, ZOOM, and elearning platform of AUTH.</li> </ul>																
<b>Teaching organization</b>	<p>The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).</p> <table border="1"> <thead> <tr> <th>Activity</th> <th>Workload/semester (hours)</th> </tr> </thead> <tbody> <tr> <td>Lectures</td> <td>32</td> </tr> <tr> <td>Laboratory work</td> <td>18</td> </tr> <tr> <td>Bibliographic Research</td> <td>16</td> </tr> <tr> <td>Written assignments</td> <td>32</td> </tr> <tr> <td>Study</td> <td>50</td> </tr> <tr> <td>Final written exam</td> <td>2</td> </tr> <tr> <td><b>Total</b></td> <td><b>150</b></td> </tr> </tbody> </table>	Activity	Workload/semester (hours)	Lectures	32	Laboratory work	18	Bibliographic Research	16	Written assignments	32	Study	50	Final written exam	2	<b>Total</b>	<b>150</b>
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Study	50																
Final written exam	2																
<b>Total</b>	<b>150</b>																
<b>Student evaluation</b>	<p><b>Assessment language</b> The assessment language is English.</p> <p><b>Assessment methods</b> Written Assignment (Summative), Performance / Staging (Summative), Written Exam with Problem Solving (Summative)</p> <p><b>Student information</b> Students are informed about the assessment process through:</p> <ul style="list-style-type: none"> <li>The course outline distributed in the first lecture.</li> <li>Detailed instructions for the written assignment and presentation posted on the course website.</li> </ul> <p>A dedicated assessment briefing during tutoring time where expectations and criteria are explained.</p>																

#### 5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1. "Electrochemical Power Sources: Batteries, Fuel Cells, and Supercapacitors ", V.S. Bagotsky, A.M. Skundin, Y.M. Volfkovich John Wiley & Sons (2015)
2. "Electrochemical Energy Storage", Reinhart Job, De Gruyter (2025)
3. "Electrochemical Energy Systems", Artur Braun, De Gruyter (2018)
4. "Hydrogen, Batteries and Fuel Cells", Bengt Sundén, Academic Press (2019)
5. "Fuel Cell Fundamentals", Ryan O'Hayre, Suk-Won Cha, Whitney Colella and Fritz B. Prinz, John Wiley & Sons (2016)

**Additional bibliography for study**

Teaching material slides

## Electronic Materials Processing

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	MSEN 823	<b>SEMESTER</b>	8th Semester
<b>COURSE TITLE</b>	Electronic Materials Processing		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		4	6
<b>COURSE TYPE</b>	<p>The Electronic Materials Processing course in Materials Engineering focuses on the materials, methods, and technologies used in the fabrication of electronic devices and components</p> <p>A. Introduction to Electronic Materials            B. Critical Material properties            C. Crystal Growth and Material Synthesis            D. Doping and Diffusion            E. Lithography and Patterning            F. Deposition and Thin Film Processing            G. Annealing and Thermal Processing            H. Packaging and Interconnects            I. Characterization Techniques</p>		
<b>PREREQUISITES</b>	Materials Science Fundamentals Solid-State Physics Thermodynamics and Kinetics		
<b>TEACHING AND EXAMINATION METHODS</b>	Lectures, Homework assignments, Quizzes, Midterm examination, Final exam		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p>By the end of the course, students will be able to:</p> <ol style="list-style-type: none"> <li>1. Understand the properties of electronic materials and their role in device performance.</li> <li>2. Apply processing techniques such as crystal growth, thin-film deposition, doping, lithography, and etching.</li> <li>3. Analyze and correlate material microstructure with electrical, optical, and mechanical properties.</li> <li>4. Perform material characterization and interpret experimental data.</li> <li>5. Evaluate and propose suitable materials and processes for specific applications.</li> </ol>

<b>General Skills</b>	Students will develop analytical and problem-solving skills, interpret surface and thin-film behavior, and apply theoretical and experimental methods to materials engineering challenges. They will also gain technical proficiency and the ability to communicate scientific results effectively.
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### 3. COURSE CONTENT

This course introduces the principles and techniques used to process materials for electronic applications. It covers the properties of semiconductors, conductors, insulators, and other functional materials, linking their structure and composition to performance in devices. Students learn about crystal growth, thin-film deposition, doping, diffusion, lithography, etching, and packaging processes. The course also emphasizes characterization techniques to evaluate structural, electrical, optical, and surface properties. Practical laboratory sessions develop skills in material fabrication, testing, and analysis. By the end, students will be able to select appropriate materials and processing methods, analyze defects, and understand their impact on electronic device functionality.

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face.													
<b>Use of ICT</b>	<p>ICT plays a significant role in enhancing teaching, learning, experimentation, visualization, and assessment in this course as follows:</p> <p><b>Computational Tools for Problem Solving:</b> Spreadsheet calculations (Excel, Google Sheets), Coding solutions in Python, MATLAB, or Mathematica</p> <p><b>Online Learning Platforms:</b> Learning management systems (LMS) like Moodle, Online lectures, video tutorials, and animations,</p> <p><b>Communication and Collaboration:</b> Online discussion forums, Collaborative documents, Sharing of data and reports</p> <p><b>Presentation and Reporting Tools:</b> Lab reports (word processors), Data plots and charts (graphing tools), Presentations (PowerPoint, Google Slides).</p>													
<b>Teaching organization</b>	<p>The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="background-color: #d9e1f2;">Activity</th> <th style="background-color: #d9e1f2;">Workload/semester (hours)</th> </tr> </thead> <tbody> <tr> <td>Lectures</td> <td style="text-align: center;">52</td> </tr> <tr> <td>self-study, quizzes, on-line tests</td> <td style="text-align: center;">46</td> </tr> <tr> <td>Independent study</td> <td style="text-align: center;">50</td> </tr> <tr> <td>examination</td> <td style="text-align: center;">2</td> </tr> <tr> <td style="background-color: #d9e1f2;"><b>Total</b></td> <td style="background-color: #d9e1f2; text-align: center;"><b>150</b></td> </tr> </tbody> </table>		Activity	Workload/semester (hours)	Lectures	52	self-study, quizzes, on-line tests	46	Independent study	50	examination	2	<b>Total</b>	<b>150</b>
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Lectures	52													
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Independent study	50													
examination	2													
<b>Total</b>	<b>150</b>													
<b>Student evaluation</b>	<p>Assessment Language: English</p> <p>Assessment Methods: Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Written Exams</p>													

### 5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

Manufacturing Technology: Materials, Processes, and Equipment | ISBN 978-1032432489 | CRC Press 2023

**Additional bibliography for study**

Principles of Electronic Materials and Devices, | ISBN 9780078028182 | McGraw Hill 2023

## Bio-inspired Engineering

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	<b>MSEN 831</b>	<b>SEMESTER</b>	8 <sup>th</sup> Semester
<b>COURSE TITLE</b>	<b>Bio-inspired Engineering</b>		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		4	6
<b>COURSE TYPE</b>	Background / General Knowledge		
<b>PREREQUISITES</b>	No prerequisites		
<b>TEACHING AND EXAMINATION METHODS</b>	English		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	No		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p>On successful completion of the module, you will be able to:</p> <ul style="list-style-type: none"> <li>• Look at nature, and the balance between nature and technology, in a different (more advanced) way.</li> <li>• Understand the fundamentals and opportunities of the nature-inspired methodology.</li> <li>• Apply fundamental principles, borrowed from natural systems, to innovate product design and solve engineering problems.</li> <li>• Recognize situations where a nature-inspired methodology might bring up a new, more performing solution.</li> <li>• Solve engineering problems by employing the nature-inspired methodology.</li> </ul>
<b>General Skills</b>	<ul style="list-style-type: none"> <li>• Problem solving with quantitative reasoning</li> <li>• Teamwork</li> <li>• Information literacy</li> <li>• Technical reporting and oral communication</li> </ul>

### 3. COURSE CONTENT

Nature-inspired methodology is introduced as a powerful approach to guide the design of new processes for applications ranging from energy and energy efficiency to chemical production and therapeutics, etc.

The module will illustrate and empower the students to apply fundamental engineering principles, underpinning desirable properties observed in nature, to achieve higher performance (efficiency, scalability, robustness, etc.) and come up with innovative approaches in interdisciplinary teams to solve challenging problems by taking guidance from natural systems that are ideally structured to achieve this high performance.

### 4. LEARNING & TEACHING METHODS – EVALUATION

<b>Teaching method</b>	Face-to-face.																	
<b>Use of ICT</b>	ICT will be used in teaching the course, and in communication with students: <ul style="list-style-type: none"> <li>teaching of the course with modern distance learning (ZOOM) and asynchronous education tools via elearning platform of AUTH,</li> </ul> communication with students via email, ZOOM, and elearning platform of AUTH.																	
<b>Teaching organization</b>	The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards). <table border="1" data-bbox="523 1160 1200 1554"> <thead> <tr> <th>Activity</th> <th>Workload/semester (hours)</th> </tr> </thead> <tbody> <tr> <td>Lectures</td> <td>30</td> </tr> <tr> <td>Tutorials / problem sessions</td> <td>20</td> </tr> <tr> <td>Bibliographic Research and analysis</td> <td>20</td> </tr> <tr> <td>Independent project work</td> <td>60</td> </tr> <tr> <td>Exam preparation / revision</td> <td>16</td> </tr> <tr> <td>Assessment</td> <td>4</td> </tr> <tr> <td><b>Total</b></td> <td><b>150</b></td> </tr> </tbody> </table>		Activity	Workload/semester (hours)	Lectures	30	Tutorials / problem sessions	20	Bibliographic Research and analysis	20	Independent project work	60	Exam preparation / revision	16	Assessment	4	<b>Total</b>	<b>150</b>
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Assessment	4																	
<b>Total</b>	<b>150</b>																	
<b>Student evaluation</b>	<b>Assessment language</b> English <b>Assessment methods</b> <b>Formative assessment</b> is designed for students in the format of quizzes, project discussion sessions, and critical reading with feedback. Project discussion sessions will be provided to assess the progress of the team-based project. Students will be asked to read bio-inspired related scientific reports and provide comments. The comments from students will be assessed to help their understanding of the papers. <b>Summative assessment</b> , which will contribute to the final mark, will be based on <ul style="list-style-type: none"> <li>Student comments on critical scientific papers on nature-inspired methodology.</li> </ul>																	

	<ul style="list-style-type: none"> <li>- Individual coursework on key concepts of nature-inspired methodology.</li> <li>- Group-based milestone presentation on the team-based project.</li> <li>- Group-based project report on the team-based project.</li> <li>•</li> </ul>
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## 5. SUGGESTED BIBLIOGRAPHY

### Course Bibliography

B. Mandelbrot, *The fractal geometry of nature*, W.H. Freeman and Co., 1983; N. Lane, *Life Ascending: The Ten Great Inventions of Evolution*, W.W. Norton & Co., 2010; S.A. Kauffman, *The Origins of Order: Self-Organization and Selection in Evolution*, Oxford University Press, 1993; R. Buckminster Fuller and D. López-Pérez, *R. Buckminster Fuller: Pattern-Thinking*, Lars Müller Publishers, 2019; D.G. Nicholls, *Bioenergetics*, Academic Press, 2013; G.M. Whitesides and B. Grzybowski, *Self-Assembly at All Scales*, *Science*, 2002, 295, pp. 2418-2421; M.-O. Coppens, *Nature-Inspired Chemical Engineering for Process Intensification*, *Annu. Rev. Chem. Biomol. Eng.* 2021, 12, pp. 187-215.

### Additional bibliography for study

Professors' notes

## Biomechanics

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	MSEN 832	<b>SEMESTER</b>	8th Semester
<b>COURSE TITLE</b>	<b>Biomechanics</b>		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		4 (3L + 1T)	6
<b>COURSE TYPE</b>	Scientific area / Skill development		
<b>PREREQUISITES</b>	Introduction to Solid Mechanics (or equivalent); recommended: basic Biology/Biochemistry for engineers.		
<b>TEACHING AND EXAMINATION METHODS</b>	Lectures and problem sessions; case studies on tissues and implants; final written exam and a short analytical assignment.		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes (taught in English, subject to minimum enrollment).		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<ul style="list-style-type: none"> <li>• Apply continuum mechanics concepts (stress, strain, constitutive laws) to biological tissues and systems.</li> <li>• Describe structure-property relations of key tissues (bone, cartilage, tendon, ligament) at multiple scales.</li> <li>• Analyze simplified biomechanical models (beams, pressure vessels, viscoelastic elements) for biological problems.</li> <li>• Explain mechanobiology concepts at an introductory level (mechanical cues and biological response).</li> <li>• Evaluate biomechanical considerations in implant/material selection (overview) and failure modes.</li> <li>• Communicate biomechanical analyses and assumptions clearly in written form.</li> </ul>
<b>General Skills</b>	<ul style="list-style-type: none"> <li>• Quantitative modeling and problem solving</li> <li>• Interdisciplinary integration (mechanics + biology + materials)</li> <li>• Critical thinking about assumptions and model limits</li> <li>• Technical communication and report writing</li> </ul>

### 3. COURSE CONTENT

- Introduction to biomechanics: scales, loading, and modelling approaches.
- Review of stress/strain, constitutive models; anisotropy and incompressibility concepts (intro).
- Mechanical behavior of biological tissues: viscoelasticity, poroelasticity concepts (intro).
- Bone biomechanics: structure, remodeling (intro), fracture and fatigue concepts.
- Soft tissue biomechanics: tendon/ligament; cartilage basics; muscle mechanics (overview).
- Cellular mechanobiology overview: adhesion, cytoskeleton, mechanotransduction (intro).
- Biomechanics in medical devices and implants: materials and design considerations (overview).
- Experimental methods overview: mechanical testing of tissues; imaging and digital image correlation (intro).
- Case studies and problem sets.

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face. Lectures combined with guided problem sessions and discussion of biomedical case studies.																
<b>Use of ICT</b>	E-learning for notes/problem sets; spreadsheet/Python tools for simple model calculations; video demonstrations of biomechanical experiments.																
<b>Teaching organization</b>	<p>The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).</p> <table border="1"> <thead> <tr> <th>Activity</th> <th>Workload/semester (hours)</th> </tr> </thead> <tbody> <tr> <td>Lectures</td> <td>39</td> </tr> <tr> <td>Tutorials / problem sessions</td> <td>13</td> </tr> <tr> <td>Analytical assignment / report</td> <td>16</td> </tr> <tr> <td>Independent study</td> <td>64</td> </tr> <tr> <td>Exam preparation</td> <td>16</td> </tr> <tr> <td>Final written exam</td> <td>2</td> </tr> <tr> <td><b>Total</b></td> <td><b>150</b></td> </tr> </tbody> </table>	Activity	Workload/semester (hours)	Lectures	39	Tutorials / problem sessions	13	Analytical assignment / report	16	Independent study	64	Exam preparation	16	Final written exam	2	<b>Total</b>	<b>150</b>
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<b>Student evaluation</b>	<p>Assessment language: English.</p> <p>Methods: written final exam (65%), analytical assignment/report (20%), quizzes/problem sets (15%). Students are informed via the course guide and e-learning announcements.</p>																

### 5. SUGGESTED BIBLIOGRAPHY

#### EUDOXUS

To be specified in EUDOXUS.

#### Additional bibliography for study

- Y.C. Fung, Biomechanics: Mechanical Properties of Living Tissues.
- S.C. Cowin (ed.), Bone Mechanics Handbook (selected chapters).
- D. Dowling, Mechanical Behavior of Materials (selected sections, for review).
- Selected open courseware notes (indicative): MIT / UC Berkeley biomechanics course materials.

## Structural Biochemistry and Bioinformatics

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	MSEN 833	<b>SEMESTER</b>	8th Semester
<b>COURSE TITLE</b>	<b>Structural Biochemistry and Bioinformatics</b>		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		4	6
<b>COURSE TYPE</b>	Background and Scientific Area		
<b>PREREQUISITES</b>	none		
<b>TEACHING AND EXAMINATION METHODS</b>	English		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>			
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p>By the end of this course, students will be able to:</p> <ul style="list-style-type: none"> <li>Analyze protein and nucleic acid structures and relate them to biological function</li> <li>Use bioinformatics databases and tools to retrieve, compare, and interpret biomolecular data</li> <li>Perform basic computational modeling and structure prediction</li> <li>Evaluate experimental structural data and understand its limitations</li> <li>Apply structural and computational principles to biomedical and biotechnological problems</li> </ul>
<b>General Skills</b>	<ul style="list-style-type: none"> <li>Searching, analyzing and synthesizing data and information</li> <li>Decision-making</li> <li>Independent work</li> <li>Teamwork</li> <li>Generate new research ideas</li> <li>Project planning and management emphasizing materials science</li> <li>Promoting free, creative and inductive thinking</li> </ul>

	<ul style="list-style-type: none"> <li>• Modeling and solving real-world problems</li> <li>• Working in a multidisciplinary environment</li> </ul>
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### 3. COURSE CONTENT

1. Levels of protein structure: primary, secondary, tertiary, quaternary
2. Non-covalent interactions in biomolecules: hydrogen bonds, hydrophobic effect, electrostatics
3. Protein folding and stability
4. Structure and dynamics of nucleic acids (DNA, RNA, hybrid structures)
5. Lipid membranes and supramolecular assemblies
6. NMR spectroscopy for biomolecular structure
7. Cryo-electron microscopy and single-particle analysis
8. Mass spectrometry for structural analysis
9. Protein modeling from experimental data
10. Introduction to Bioinformatics (Biological databases: UniProt, PDB, GenBank, Sequence alignment: BLAST, FASTA, multiple sequence alignment, Genome annotation and functional prediction)
11. Structural Bioinformatics (Protein structure prediction: homology modeling, threading, ab initio, Molecular visualization, Structure–function relationships, Active sites and ligand binding)
12. Computational Tools and Algorithms (Molecular dynamics simulations, Docking methods for protein–ligand and protein–protein complexes, Machine learning in structural biology e.g., AlphaFold)

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face.	
<b>Use of ICT</b>	Use of ICT in Course Teaching, Use of ICT in Communication with Students Description: Use of Information and Communication Technologies (ICT) in teaching the course with tools of modern distance learning (ZOOM) and asynchronous education (eclass). Use of learning aids based on ICT: Excel, Word, Power Point Use of ICT in student assessment: Electronic grading (eclass, universis). <ul style="list-style-type: none"> <li>• Use of ICT in communication with students: eclass, email, ZOOM.</li> </ul>	
<b>Teaching organization</b>	The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).	
	<b>Activity</b>	<b>Workload/semester (hours)</b>
	Lectures	52
	Tutorial	13
	Bibliographic Research	57
	Written assignments	25
	exam	2
	<b>Total</b>	<b>150</b>

<b>Student evaluation</b>	<p>Assessment Language: English</p> <p>Assessment Methods:</p> <ul style="list-style-type: none"> <li>• Short Answer Questions,</li> <li>• Essay Development Questions,</li> <li>• Multiple Choice Test</li> <li>• Problem Solving</li> <li>• Oral Exam</li> <li>• Written exams</li> </ul>
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#### 5. SUGGESTED BIBLIOGRAPHY

##### EUDOXUS

Structural Bioinformatics, Jenny Gu, Philip E. Bourne, (2<sup>nd</sup> Edition). ISBN: 9780470181058  
 Introduction to Protein Structure, Carl Branden, John Tooze, (2<sup>nd</sup> Edition), ISBN: 978-0815323051

##### Additional bibliography for study

Teaching material slides

## Diploma Thesis

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>		<b>SEMESTER</b>	8 <sup>th</sup> Semester
<b>COURSE TITLE</b>	Diploma Thesis		
<b>TEACHING ACTIVITIES</b> Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>	
	0 (independent research; supervision meetings as needed)	12	
<b>COURSE TYPE</b>	Degree project / Independent research or engineering design project		
<b>PREREQUISITES</b>	Approval of thesis topic and supervisor.		
<b>TEACHING AND EXAMINATION METHODS</b>	Continuous supervision with milestone reviews; submission of written thesis; oral presentation and defense before an examination committee; evaluation according to programme regulations.		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes (taught in English, subject to minimum enrollment).		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p>Upon successful completion, students will be able to:</p> <ul style="list-style-type: none"> <li>• Define a complex materials-related problem, formulate objectives, and develop an appropriate methodology.</li> <li>• Perform an in-depth literature review and position the work within current state-of-the-art.</li> <li>• Execute research/design work (experimental, computational, or analytical) applying safe and responsible practices.</li> </ul>
<b>General Skills</b>	<p>Independent work and initiative Advanced problem solving Research integrity and ethics Project planning and risk management Scientific/technical writing and oral defense Teamwork and communication with supervisor/lab members</p>

3. COURSE CONTENT
Typical phases: topic definition and proposal; literature review; methodology selection; experimental/computational execution; data analysis and validation; drafting of thesis; final revisions; presentation and oral defense.

4. LEARNING & TEACHING METHODS - EVALUATION	
<b>Teaching method</b>	Supervised independent project. Individual meetings and/or group research meetings; training on specific methods/instruments as required; iterative feedback on written deliverables.
<b>Use of ICT</b>	Learning management system for announcements and templates; access to digital libraries and databases; discipline-appropriate software (e.g., CAD/FEA, thermodynamic databases, microscopy software, Python/Matlab) depending on topic; plagiarism check tools per university policy (if used).
<b>Teaching organization</b>	Indicative workload (12 ECTS): research/design work and study; writing;
<b>Student evaluation</b>	Assessment language: English. Evaluation by committee based on: quality and originality of work; adequacy of methodology; analysis and discussion; thesis structure and writing quality; proper citations and ethics; degree of independence; oral presentation and defense. Grading rubric and procedure follow programme regulations.

5. SUGGESTED BIBLIOGRAPHY	
<b>EUDOXUS</b>	
Not applicable (seminar-based course).	
<b>Additional bibliography for study</b>	
Topic-specific scientific literature (journal papers, standards, handbooks) selected jointly by the student and supervisor. Programme-provided thesis writing and formatting guidelines (templates, citation standards) apply.	

## 9<sup>th</sup> Semester

### Computational Methods in Engineering Design

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme)		
<b>COURSE CODE</b>	<b>MSEN 901</b>	<b>SEMESTER</b>	9 <sup>th</sup> Semester
<b>COURSE TITLE</b>	<b>Computational Methods in Engineering Design</b>		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		4 (3L + 1T)	6
<b>COURSE TYPE</b>	Scientific area / Skills development		
<b>PREREQUISITES</b>	Introduction to Solid Mechanics, Design and Analysis of Materials Experiments, CAD-CAE in materials engineering		
<b>TEACHING AND EXAMINATION METHODS</b>	Face-to-face		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p>By the end of this course, students will be able to:</p> <ul style="list-style-type: none"> <li>Analyze and design real world structures using modern computational tools</li> <li>Analyze structures under real-world operational conditions</li> <li>Problem identification and problem solving on design of structures</li> <li>Optimize the design of structures</li> </ul>
<b>General Skills</b>	<ul style="list-style-type: none"> <li>Search for, analysis and synthesis of data and information, with the use of the necessary technology</li> <li>Work in an international context</li> <li>Advance free, creative and causative thinking</li> <li>Work in teams</li> <li>Decision-making</li> <li>Modeling and solving real-world problems</li> <li>Working in a multidisciplinary environment</li> <li>Generate new research ideas</li> </ul>

### 3. COURSE CONTENT

This course provides a comprehensive framework for applying computational software and techniques to the engineering design process. Shifting beyond basic stress analysis, students will learn to utilize commercial simulation software as a primary tool for design synthesis and optimization.

Key topics:

- Simulation-Driven Design - utilizing CAE software to perform parametric and sensitivity analyses
- Structural Optimization.
- Design Automation & Scripting

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face.	
<b>Use of ICT</b>	Use of ICT in Course Teaching, Use of ICT in Communication with Students Description: Use of Information and Communication Technologies (ICT) in teaching the course with tools of modern distance learning (MS-Teams) and asynchronous education (e-learning). Use of learning aids based on ICT: Excel, Matlab, CAE software Use of ICT in student assessment: Electronic grading (e-learning). Use of ICT in communication with students: e-learning, email, MS-Teams.	
<b>Teaching organization</b>	The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).	
	<b>Activity</b>	<b>Workload/semester (hours)</b>
	Lectures	39
	Tutorials / problem sessions	13
	Short assignments / quizzes	10
	Independent study	70
	Exam preparation	16
	Final written exam	2
	<b>Total</b>	<b>150</b>
<b>Student evaluation</b>	Report Oral exams Written Exams with Problem Solving (Summative)	

### 5. SUGGESTED BIBLIOGRAPHY

#### EUDOXUS

To be specified in EUDOXUS.

#### Additional bibliography for study

1. Pawel M. Kurowski (2016). Finite Element Analysis for Design Engineers (2nd Edition), SAE International
2. A.F. Hobbacher, J. Baumgartner (2024). Recommendations for Fatigue Design of Welded Joints and Components (3rd Edition). International institute of Welding, Springer.

## Materials and Environment

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme)		
<b>COURSE CODE</b>	<b>MSEN 902</b>	<b>SEMESTER</b>	9 <sup>th</sup> Semester
<b>COURSE TITLE</b>	Materials and Environment		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		4 (3L + 1T)	6
<b>COURSE TYPE</b>	Background / General knowledge / Scientific area		
<b>PREREQUISITES</b>	None		
<b>TEACHING AND EXAMINATION METHODS</b>	Face-to-face lectures and guided problem-solving sessions; short in-class quizzes; final written examination.		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes.		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p>Upon successful completion of the course, students will be able to:</p> <ul style="list-style-type: none"> <li>• Explain the fundamental concepts, sources, and transport mechanisms of environmental pollutants, as well as key pollution control and waste management technologies.</li> <li>• Analyze the relationship between material structure, physicochemical properties, and environmental performance.</li> <li>• Identify the main categories of materials, understand their properties, and evaluate their suitability for environmental technologies and pollution mitigation applications.</li> <li>• Assess the potential of innovative materials for pollution control and sustainable environmental solutions.</li> <li>• Evaluate the environmental impacts of specific material categories throughout their life cycle, including production, use, and end-of-life disposal, and discuss their potential for recycling and reuse.</li> </ul>
<b>General Skills</b>	<ul style="list-style-type: none"> <li>• Problem solving with quantitative reasoning</li> <li>• Teamwork in tutorial and lab-style activities</li> <li>• Information literacy (handbooks, databases, standards awareness)</li> <li>• Technical reporting and oral communication</li> <li>• Ethics and sustainability awareness in materials choices</li> </ul>

### 3. COURSE CONTENT

The course *Materials and Environment* introduces students to the fundamental principles of environmental engineering and the interactions between materials and the environment. It begins with an overview of environmental pollution, including the generation, transport, and fate of pollutants in air, water, and soil, and discusses applied technologies for pollution control and environmental protection. Students study the role of materials in pollution mitigation, focusing on their physicochemical and structural properties, surface interactions, and key processes in anti-pollution technologies. Specific topics include gas catalysis and catalytic materials, heterogeneous photocatalysis and photocatalytic materials, adsorption and adsorbent materials, molecular imprinting for pollutant removal, and the management of special solid wastes. The course also examines polymers, including their properties, environmental behavior, ecological impacts, and waste management strategies, as well as biodegradable polymers and their applications. Asbestos, cement, and concrete are discussed regarding their properties, environmental impacts, toxicity, and life-cycle considerations. Emphasis is placed on life-cycle assessment (LCA) of materials to evaluate sustainability and environmental performance. Through lectures, case studies, and practical examples, students gain the knowledge and skills necessary to understand, evaluate, and apply materials-based strategies for environmental protection and sustainable engineering.

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face. Lectures, guided problem sessions, short demonstrations, and small-group activities/case studies.	
<b>Use of ICT</b>	Learning management system (e-learning platform) for notes, quizzes and announcements; spreadsheets for simple property charts; basic use of materials databases for information retrieval.	
<b>Teaching organization</b>	The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).	
	<b>Activity</b>	<b>Workload/semester (hours)</b>
	Lectures	39
	Tutorials / problem sessions	13
	Short assignments / quizzes	10
	Independent study	70
	Exam preparation	16
	Final written exam	2
<b>Total</b>	<b>150</b>	
<b>Student evaluation</b>	Assessment language: English. Methods: written final exam (60%), homework/problem sets and short quizzes (25%), mini-case study/report (15%). Students are informed via the course guide and e-learning announcements.	

### 5. SUGGESTED BIBLIOGRAPHY

#### EUDOXUS

To be specified in EUDOXUS.

#### Additional bibliography for study

- Environmental Nanotechnology: Applications and Impacts of Nanomaterials (1st Ed) M. Wiesner, J.-Y. Bottero, McGraw-Hill Education, 2007.
- Degradable Polymers, Recycling, and Plastics Waste Management A-C. Albertson, S.J, Huang, 1995 Marcel-Dekker.
- Materials Characterization Techniques, Sam Zhang, Lin Li, Ashok Kumar (2008) CRC Press.
- Physical Methods for Materials Characterisation, Peter E.J. Flewitt, R.K. Wild (2003) CRC Press.

## Research Methodology

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme)		
<b>COURSE CODE</b>	<b>MSEN 903</b>	<b>SEMESTER</b>	9 <sup>th</sup> Semester
<b>COURSE TITLE</b>	Research Methodology		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		2	3
<b>COURSE TYPE</b>	Scientific area / Research skills development		
<b>PREREQUISITES</b>	Recommended: completion of core materials science and engineering courses (Semesters 1–8). Basic statistics and data analysis familiarity is helpful.		
<b>TEACHING AND EXAMINATION METHODS</b>	Face-to-face lectures and workshops; guided individual exercises; formative feedback sessions; final written assignment and/or written examination (as defined in the course guide).		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes (taught in English, subject to minimum enrollment).		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p>Upon successful completion, students will be able to:</p> <ul style="list-style-type: none"> <li>• Formulate research questions/hypotheses and define measurable objectives.</li> <li>• Conduct a structured literature review using scientific databases and critical appraisal.</li> <li>• Design a research plan (experimental, computational, or analytical) including risk and resource planning.</li> <li>• Apply good practices in data management, basic statistics, uncertainty, and reproducibility.</li> <li>• Write a research proposal/report using appropriate academic style, citations, and ethical standards.</li> <li>• Present research plans and results clearly (oral and written), responding to peer review.</li> </ul>
<b>General Skills</b>	<p>Scientific writing and communication            Information literacy and critical thinking            Project planning and time management            Teamwork and peer-feedback            Ethics, integrity, and responsible research conduct</p>

### 3. COURSE CONTENT

Scientific method and hypothesis-driven research; research questions and objectives; research designs in materials science (experimental/computational); literature search strategies and critical reading; reference management and citation styles; research planning (milestones, Gantt charts, risk assessment, safety); data management plans, FAIR principles, lab notebooks; basic statistical concepts, uncertainty and error propagation; reporting results and discussion; plagiarism avoidance, authorship, peer review; research ethics, open science and reproducibility; preparing research proposals and presentations.

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face. Short lectures combined with workshops, guided activities, case studies, and peer-review of mini-assignments.
<b>Use of ICT</b>	Learning management system (e-learning platform); scientific databases (Scopus/Web of Science/Google Scholar); reference managers (Zotero/Mendeley); basic data analysis tools (Excel/Python/Matlab as appropriate).
<b>Teaching organization</b>	Indicative workload (3 ECTS $\approx$ 75 hours): Lectures/workshops 26 h; guided exercises 10 h; independent study 25 h; preparation of proposal/report and presentation 14 h.
<b>Student evaluation</b>	Assessment language: English. Indicative methods: (i) Individual research proposal or literature review report (50–70%), (ii) Oral presentation and discussion (20–30%), (iii) Short quizzes/participation (0–20%). Exact weights are announced in the course guide.

### 5. SUGGESTED BIBLIOGRAPHY

#### EUDOXUS

To be specified in EUDOXUS.

#### Additional bibliography for study

Creswell, J.W. & Creswell, J.D., Research Design: Qualitative, Quantitative, and Mixed Methods Approaches.

Booth, W.C., Colomb, G.G., & Williams, J.M., The Craft of Research.

Day, R.A. & Gastel, B., How to Write and Publish a Scientific Paper.

Selected journal articles and instructor notes tailored to materials science and engineering.

## 10<sup>th</sup> Semester

### Smart Materials and Systems

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme)		
<b>COURSE CODE</b>	MSEN 1001	<b>SEMESTER</b>	10 <sup>th</sup> Semester
<b>COURSE TITLE</b>	<b>Smart Materials and Systems</b>		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		4 (3L + 1T)	6
<b>COURSE TYPE</b>	Skill development / Scientific area		
<b>PREREQUISITES</b>			
<b>TEACHING AND EXAMINATION METHODS</b>	English		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p>Upon successful completion of the course, undergraduate students will be able to:</p> <ul style="list-style-type: none"> <li>• Describe the basic principles and behavior of smart materials and adaptive systems.</li> <li>• Identify major classes of smart materials, including shape memory alloys, piezoelectric, magnetostrictive, and electroactive materials.</li> <li>• Explain the mechanisms by which smart materials sense, respond, and adapt to external stimuli.</li> <li>• Understand how smart materials are integrated into engineering systems for sensing, actuation, and energy harvesting.</li> <li>• Recognize key applications of smart materials in fields such as robotics, aerospace, biomedical devices, and structural health monitoring.</li> <li>• Relate material behavior to simple design considerations and functional performance in engineering applications.</li> </ul>

<b>General Skills</b>	<ul style="list-style-type: none"> <li>• Systems thinking in design decisions</li> <li>• Data-driven decision making with uncertainty</li> <li>• Project planning and teamwork</li> <li>• Professional reporting and presentations</li> </ul>
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### 3. COURSE CONTENT

This course provides a comprehensive introduction to the principles, behavior, and applications of smart materials and adaptive systems. Topics include shape memory alloys, piezoelectric and magnetostrictive materials, electroactive polymers, and stimuli-responsive composites. Students explore the mechanisms that enable materials to sense, respond, and adapt to environmental changes, and examine how these materials are integrated into devices and systems for actuation, sensing, and energy harvesting. Applications in robotics, aerospace, biomedical devices, and structural health monitoring are emphasized throughout.

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face.																
<b>Use of ICT</b>	Learning management system (e-learning platform) for notes, quizzes and announcements; spreadsheets for simple property charts; basic use of materials databases for information retrieval.																
<b>Teaching organization</b>	<p>The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="background-color: #e1eef6;">Activity</th> <th style="background-color: #e1eef6;">Workload/semester (hours)</th> </tr> </thead> <tbody> <tr> <td>Lectures</td> <td style="text-align: center;">39</td> </tr> <tr> <td>Tutorials / problem sessions</td> <td style="text-align: center;">13</td> </tr> <tr> <td>Short assignments / quizzes</td> <td style="text-align: center;">10</td> </tr> <tr> <td>Independent study</td> <td style="text-align: center;">70</td> </tr> <tr> <td>Exam preparation</td> <td style="text-align: center;">16</td> </tr> <tr> <td>Final written exam</td> <td style="text-align: center;">2</td> </tr> <tr> <td style="background-color: #e1eef6;"><b>Total</b></td> <td style="background-color: #e1eef6; text-align: center;"><b>150</b></td> </tr> </tbody> </table>	Activity	Workload/semester (hours)	Lectures	39	Tutorials / problem sessions	13	Short assignments / quizzes	10	Independent study	70	Exam preparation	16	Final written exam	2	<b>Total</b>	<b>150</b>
Activity	Workload/semester (hours)																
Lectures	39																
Tutorials / problem sessions	13																
Short assignments / quizzes	10																
Independent study	70																
Exam preparation	16																
Final written exam	2																
<b>Total</b>	<b>150</b>																
<b>Student evaluation</b>	<p>Assessment language: English.</p> <p>Methods: written final exam (60%), homework/problem sets and short quizzes (25%), mini-case study/report (15%). Students are informed via the course guide and e-learning announcements.</p>																

### 5. SUGGESTED BIBLIOGRAPHY

<b>EUDOXUS</b>
To be specified in EUDOXUS.
<b>Additional bibliography for study</b>
Teaching material slides

## Artificial Intelligence and Machine Learning in Materials Science and Engineering

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme)		
<b>COURSE CODE</b>	MSEN 1002	<b>SEMESTER</b>	10 <sup>th</sup> Semester
<b>COURSE TITLE</b>	<b>Artificial Intelligence and Machine Learning in Materials Science and Engineering</b>		
<b>TEACHING ACTIVITIES</b> Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.		<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		Lectures: 2 Lab work: 2 Total: 4	6
<b>COURSE TYPE</b>	Scientific Area, Skill Development		
<b>PREREQUISITES</b>	<ul style="list-style-type: none"> <li>• Mathematics I – Algebra, Analytic Geometry and Introduction to Calculus</li> <li>• Mathematics II – Advanced Calculus</li> <li>• Mathematics III – Differential Equations</li> <li>• Materials Informatics</li> <li>• Bonding, Crystallography, Crystal Defects</li> <li>• Physical Chemistry</li> </ul>		
<b>TEACHING AND EXAMINATION METHODS</b>	Lectures, computer-based labs, project work, final presentation (in English)		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>			
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p><b>Upon successful completion of the course, students will be able to:</b></p> <ul style="list-style-type: none"> <li>• Understand the theoretical foundations of machine learning and AI algorithms.</li> <li>• Apply Scikit-learn, TensorFlow, and PyTorch to materials datasets.</li> <li>• Develop ML models for property prediction, classification, and clustering in energy materials.</li> <li>• Evaluate model performance, interpret results, and connect them to physical principles.</li> <li>• Integrate ML workflows with computational simulations and experimental data.</li> </ul>

	<ul style="list-style-type: none"> <li>Design and execute a project applying ML/AI to a real materials science or energy engineering problem.</li> </ul>
<b>General Skills</b>	<ul style="list-style-type: none"> <li>Systems thinking in design decisions</li> <li>Data-driven decision making with uncertainty</li> <li>Project planning and teamwork</li> <li>Professional reporting and presentations</li> </ul>

### 3. COURSE CONTENT

#### Topic-based outline:

- Introduction: AI/ML in materials science and engineering
- Review of mathematical foundations (linear algebra, calculus, differential equations)
- Supervised learning: regression, classification, decision trees, random forests
- Neural networks: fundamentals, backpropagation, deep learning architectures
- Unsupervised learning: clustering, dimensionality reduction (PCA, t-SNE)
- Reinforcement learning basics and potential applications in materials design
- Model evaluation: metrics, cross-validation, overfitting/underfitting
- Applications in energy and materials:
  - Battery materials (lithium-ion, solid-state)
  - Catalysts for sustainable energy
  - Polymers and recycling pathways
  - Defect engineering and crystallography
- Integration with simulations: combining ML with molecular dynamics and DFT data
- Ethical and practical considerations in AI-driven materials discovery
- Student project development and presentation

#### 13-week course structure:

- Weeks 1–2:** Introduction, mathematical foundations, Python ML libraries
- Weeks 3–4:** Supervised learning methods (Scikit-learn)
- Weeks 5–6:** Neural networks and deep learning (TensorFlow, PyTorch)
- Weeks 7–8:** Unsupervised learning and dimensionality reduction
- Weeks 9–10:** Applications in energy materials (case studies)
- Weeks 11–12:** Integration with simulations, advanced topics (reinforcement learning, ethics)
- Week 13:** Project presentations and synthesis

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face.								
<b>Use of ICT</b>	<p>Python programming, Scikit-learn, TensorFlow, PyTorch, Jupyter notebooks, e-learning platform.</p> <p>Use of ICT in student assessment: Electronic grading (eclass, universis).</p> <p>Use of ICT in communication with students: eclass, email, ZOOM.</p>								
<b>Teaching organization</b>	<p>The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).</p> <table border="1"> <thead> <tr> <th>Activity</th> <th>Workload/semester (hours)</th> </tr> </thead> <tbody> <tr> <td>Lectures</td> <td>26</td> </tr> <tr> <td>Laboratory Exercise</td> <td>26</td> </tr> <tr> <td>Bibliography</td> <td>56</td> </tr> </tbody> </table>	Activity	Workload/semester (hours)	Lectures	26	Laboratory Exercise	26	Bibliography	56
Activity	Workload/semester (hours)								
Lectures	26								
Laboratory Exercise	26								
Bibliography	56								

	Written assignment	42
	<b>Total</b>	<b>150</b>
<b>Student evaluation</b>	Assessment Language: English Assessment Methods: <ul style="list-style-type: none"> <li>• Project — dataset selection, ML workflow, report, and presentation</li> <li>• Lab assignments</li> </ul> Written exam	

## 5. SUGGESTED BIBLIOGRAPHY

### EUDOXUS

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### Additional bibliography for study

- Rajan, K. Materials Informatics (Elsevier, 2013)
- Ramprasad, R. et al. Machine Learning in Materials Science (Annual Review of Materials Research, 2017)
- Butler, K. T. et al. Machine Learning for Molecular and Materials Science (Nature, 2018)
- Géron, A. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow (O'Reilly, 2019)
- Goodfellow, I., Bengio, Y., Courville, A. Deep Learning (MIT Press, 2016)
- Online resources: Materials Project, NOMAD, AFLOW, OQMD

## Seminars (Soft Skills, Entrepreneurship & Innovation, IP Rights, Patents, Startups)

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme)		
<b>COURSE CODE</b>	<b>MSEN 1003</b>	<b>SEMESTER</b>	10 <sup>th</sup> Semester
<b>COURSE TITLE</b>	Seminars (Soft Skills, Entrepreneurship & Innovation, IP Rights, Patents, Startups)		
<b>TEACHING ACTIVITIES</b>	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>	
Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	1 seminar / month	3	
<b>COURSE TYPE</b>	Skills development / Professional practice		
<b>PREREQUISITES</b>	None. Recommended: students in the final year (9th–10th semester) to maximize relevance for thesis and transition to industry/PhD.		
<b>TEACHING AND EXAMINATION METHODS</b>	Seminar attendance and active participation; short written reflections; team-based tasks (e.g., innovation case, pitch); optional final portfolio submission.		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes (taught in English, subject to minimum enrollment).		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p>Upon successful completion, students will be able to:</p> <ul style="list-style-type: none"> <li>• Communicate technical ideas effectively to specialist and non-specialist audiences (writing, speaking, pitching).</li> <li>• Work in teams, manage conflict, and organize tasks in multidisciplinary settings.</li> <li>• Apply basic principles of entrepreneurship and innovation (problem–solution fit, value proposition, business models).</li> <li>• Understand fundamentals of intellectual property (IP), patents, and technology transfer pathways.</li> <li>• Recognize steps for creating and scaling a startup, including funding, prototyping, and market validation.</li> <li>• Demonstrate professional conduct, ethics, and awareness of societal/environmental impact.</li> </ul>
<b>General Skills</b>	<p>Communication and presentation skills            Teamwork and leadership            Project and time management            Entrepreneurial mindset and creativity            Negotiation and professional ethics</p>

### 3. COURSE CONTENT

Soft skills: communication, technical writing, presentations, teamwork, leadership, negotiation, conflict management, project management. Entrepreneurship & innovation: ideation, customer discovery, value proposition, business model basics, go-to-market, funding landscape. IP and patents: types of IP, patentability criteria, prior-art search, patent drafting overview, freedom-to-operate basics, licensing. Startups and innovation ecosystem: incubators/accelerators, spin-offs, regulatory basics (where relevant), case studies from materials/medtech/energy domains, guest speakers from industry and technology transfer offices.

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Seminar-based learning with invited speakers and facilitated workshops; experiential learning through case studies and team activities.
<b>Use of ICT</b>	Learning management system for materials; collaborative tools (shared documents, forums); optional use of online patent databases and market research resources.
<b>Teaching organization</b>	Indicative workload (3 ECTS $\approx$ 75 hours): Seminars/workshops 26 h; preparation and reading 25 h; reflective assignments/portfolio 24 h.
<b>Student evaluation</b>	Assessment language: English. Indicative methods: Participation/attendance (30–40%); Individual reflections (20–30%); Team case study and pitch/portfolio (30–50%). Exact weights are announced in the course guide.

### 5. SUGGESTED BIBLIOGRAPHY

#### EUDOXUS

Not applicable (seminar-based course).

#### Additional bibliography for study

Osterwalder, A. & Pigneur, Y., Business Model Generation.

Blank, S. & Dorf, B., The Startup Owner's Manual.

Selected resources from WIPO/EPO on IP and patents; case studies provided by instructors/guest speakers.

## Diploma Thesis I & II

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme)		
<b>COURSE CODE</b>	<b>MSEN 904</b> <b>MSEN 1004</b>	<b>SEMESTER</b>	9th & 10th Semesters (two-semester thesis; 15 ECTS + 15 ECTS)
<b>COURSE TITLE</b>	Diploma Thesis		
<b>TEACHING ACTIVITIES</b>	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>	
Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.			
	0 (independent research; supervision meetings as needed)	30	
<b>COURSE TYPE</b>	Degree project / Independent research or engineering design project		
<b>PREREQUISITES</b>	Approval of thesis topic and supervisor. Normally requires completion of core coursework and sufficient accumulated ECTS as defined by the programme regulations. Compliance with laboratory safety and research ethics training (where applicable).		
<b>TEACHING AND EXAMINATION METHODS</b>	Continuous supervision with milestone reviews; submission of written thesis; oral presentation and defense before an examination committee; evaluation according to programme regulations.		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes (taught in English, subject to minimum enrollment).		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	<p>Upon successful completion, students will be able to:</p> <ul style="list-style-type: none"> <li>• Define a complex materials-related problem, formulate objectives, and develop an appropriate methodology.</li> <li>• Perform an in-depth literature review and position the work within current state-of-the-art.</li> <li>• Execute research/design work (experimental, computational, or analytical) applying safe and responsible practices.</li> <li>• Analyze and interpret results critically, including uncertainty and limitations.</li> <li>• Produce a coherent technical dissertation meeting academic standards and proper citation/ethics.</li> <li>• Present and defend the work effectively, responding to questions and feedback.</li> </ul>

	<ul style="list-style-type: none"> <li>• Demonstrate autonomy, project management, and professional responsibility.</li> </ul>
<b>General Skills</b>	<p>Independent work and initiative          Advanced problem solving          Research integrity and ethics          Project planning and risk management          Scientific/technical writing and oral defense          Teamwork and communication with supervisor/lab members</p>

### 3. COURSE CONTENT

Two-semester capstone project (15 ECTS in 9th semester + 15 ECTS in 10th semester).  
 Typical phases: topic definition and proposal; literature review; methodology selection; experimental/computational execution; data analysis and validation; drafting of thesis; final revisions; presentation and oral defense.  
 The exact content is tailored to the chosen thesis topic and may involve laboratory work, simulations, materials design, processing, characterization, performance evaluation, sustainability analysis, or industrial case studies.

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Supervised independent project. Individual meetings and/or group research meetings; training on specific methods/instruments as required; iterative feedback on written deliverables.
<b>Use of ICT</b>	Learning management system for announcements and templates; access to digital libraries and databases; discipline-appropriate software (e.g., CAD/FEA, thermodynamic databases, microscopy software, Python/Matlab) depending on topic; plagiarism check tools per university policy (if used).
<b>Teaching organization</b>	Indicative workload (30 ECTS $\approx$ 750 hours total; 15 ECTS per semester $\approx$ 375 hours): research/design work and study $\sim$ 650 h; writing $\sim$ 80 h; meetings, presentations, and defense preparation $\sim$ 20 h. Milestones and intermediate deliverables are defined with the supervisor.
<b>Student evaluation</b>	Assessment language: English. Evaluation by committee based on: quality and originality of work; adequacy of methodology; analysis and discussion; thesis structure and writing quality; proper citations and ethics; degree of independence; oral presentation and defense. Grading rubric and procedure follow programme regulations.

### 5. SUGGESTED BIBLIOGRAPHY

#### EUDOXUS

Not applicable (seminar-based course).

#### Additional bibliography for study

Topic-specific scientific literature (journal papers, standards, handbooks) selected jointly by the student and supervisor. Programme-provided thesis writing and formatting guidelines (templates, citation standards) apply.