# COURSE OUTLINE

## 1. COURSE INFORMATION

| | | | |
|---|---|---|---|
| **SCHOOL** | Technical University of Crete | | |
| **DEPARTMENT** | Mineral Resources Engineering | | |
| **COURSE LEVEL** | Graduate | | |
| **COURSE ID** | | **SEMESTER** | Winter |
| **COURSE TITLE** | Fossil Fuels and Energy Transition | | |

| **COURSE MODULES** *in the case of credits being awarded in distinct parts of the course eg. Lectures, Laboratory Exercises, etc. If credit units are awarded uniformly for the whole course, indicate the weekly hours of teaching and the total number of credits.* | **INSTRUCTION HOURS PER WEEK** | **CREDITS** |
|---|---|---|
| Lectures | 3 | |
| PBL | | |
| Laboratories | | |
| Tutorial Exercises | | |
| **Total** | 3 | 10 |
| *Add rows if needed. The teaching organization and teaching methods used are described in detail in (4).* | | |

| | |
|---|---|
| **COURSE TYPE** *Background, General Knowledge, Scientific Area, Skills Development* | Specialization background |
| **PREREQUISITES:** | |
| **INSTRUCTION/EXAM LANGUAGE:** | English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS:** | Yes |
| **COURSE URL:** | EURECA-PRO LMS Moodle URL: https://moodle.eurecapro.tuc.gr/course/view.php?id=135 |

## 2. LEARNING OUTCOMES

**Learning Outcomes**

*The learning outcomes of the course describe the specific knowledge, skills and competences of an appropriate level that students will acquire after successfully completing the course.*

*Refer to Appendix A.*

- *Description of the Level of Learning Outcomes for each course of study in line with the European Higher Education Area Qualifications Framework*
- *Descriptive Indicators of Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Annex B*
- *Learning Outcomes Writing Guide*

- Analyse Analyze energy production systems in terms of efficiency and their environmental impacts (both in the short and longer term).
- Propose Propose and design efficient and sustainable energy production and transformation process utilizing different power sources in ways that are compatible with recent EU net-zero carbon directives.
- Develop Develop independent and analytic thinking and effective response to complex design problems with both economic and environmental impact

**General Competencies/Skills**

*Considering the general competencies that the graduate must have acquired (as listed in the Diploma Supplement and below), which one(s) the course enhances?*

| | |
|---|---|
| *Search, analysis and synthesis of data and information, using the necessary technologies* | *Project design and management* |
| *Adaptation to new situations* | *Respect for diversity and multiculturalism* |
| *Decision making* | *Respect for the natural environment* |
| *Autonomous work* | *Demonstration of social, professional and moral responsibility and sensitivity to gender issues* |
| *Teamwork* | *Exercise criticism and self-criticism* |

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| | |
|---|---|
| *Working in an international environment*<br>*Working in an interdisciplinary environment*<br>*Production of new research ideas* | *Promoting free, creative and inductive thinking* |

- Research, analysis and synthesis of data and information, using the necessary technologies
- Decision-making
- Project design and Management
- Respect for the natural environment
- Demonstrating social, professional and ethical responsibility and sensitivity to gender issues
- Promoting free, creative and inductive thinking
- Oral communication
- Initiative
- Problem Solving
- Work in interdisciplinary environment

## 3. COURSE SYLLABUS

This course focuses on conventional and renewable energy technologies within the framework of the European net-zero carbon target for 2050. The students will be progressively introduced to the primary energy sources and their basic transformation processes, including Fossil Fuels (Oil, Gas, Coal) and their uses in Internal Combustion Engines and Thermal Power Stations, Solar and Wind Energy Systems, Thermal and Photovoltaic Solar Systems, and Hydroelectric plants. The course will also cover the Environmental and Climate Impact of Energy-related Processes, including global warming from CO2 production, transitional mitigation strategies, such as CCS, and the European Energy Transition Strategies and Policies. The technological bottlenecks related to energy storage from renewables, the transfer of energy in the form of synthetic fuels (methane, hydrogen) and their integration in the power grid will also be discussed.

The course will be delivered in 13 weeks according to the following weekly schedule:

1. Introduction to basic forms of energy
2. Basic energy transformation processes
3. Fossil fuels and related energy systems
4. Environmental impacts of carbon-based fuels
5. EU energy policies and directives
6. Carbon capture and storage and transitional technologies
7. Renewable Energy Systems (Solar, Aeolian)
8. Renewable Energy Systems (Biomass, Geothermal)
9. Nuclear and Hydroelectric power plants
10. Contribution of different energy sources in global power production and consumption – Main importers and exporters of energy
11. Transitional energy production, transport, and consumption technologies
12. Technological Bottlenecks for novel energy production systems
13. Costs and Life-cycle assessment of novel technologies

## 4. TEACHING and LEARNING METHODS – ASSESSMENT

| | | |
|---|---|---|
| **LECTURE METHOD**<br>*Face to face, distance learning, etc.* | Face to face, distant learning | |
| **USE OF INFORMATION AND COMMUNICATION TECHNOLOGY**<br>*Use of ICT in Teaching, in Laboratory Exercises, in Communication with students* | - Powerpoint presentations<br>- Educational videos<br><br>- Moodle platform<br>- Online data repositories<br>- Email | |
| **TEACHING ORGANISATION** | ***ACTIVITY*** | ***Workload per semester (in Hours)*** |

| | |
|---|---|
| *Describe in detail the way and methods of teaching.*<br>*Lectures, Seminars, Laboratory Exercise, Field Exercise, Literature review & analysis, Tutoring, Practice (Placement), Clinical Exercise, Artistic Lab, Interactive teaching, Educational visits, Project work, project, etc.*<br><br>*The student's study hours for each learning activity and the hours of non-guided study according to the ECTS principles are mentioned.* | |

| | |
|---|---|
| Lectures | 39 |
| Individual Project | 100 |
| Research/Study | 101 |
| Seminars | 10 |
| ***Course Total (25 hours' workload/ECTS credit)*** | ***250*** |

**ASSESSMENT METHODS**

*Description of the evaluation process*

*Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Public Presentation, Laboratory Assignment, Clinical Examination of Patients, Artistic Interpretation, Other*

*Well defined student assessment criteria are mentioned. Mention whether and how the students can access them.*

Collective / Concluding (for student degree) assessmen

| | | |
|---|---|---|
| Written Final Examination | 60% | Multiple Choice Questions / Matching; Short answer questions; Problem solving questions |
| Individual Project | 40% | (Public Presentation) |

## 5. DIGITIZATION (use of tools & software)

Students are required to perform calculations in Microsoft Excel spreadsheets (mass balance, economic and energy indicators etc) using the relevant tools and also prepare ppt presentations. The use of COMSOL Multiphysics will be demonstrated for the modeling of flow and reaction kinetics in fluidized beds.

## 6. RECOMMENDED INTERNATIONAL LITERATURE

• Energy Technologies and Economics, P.A Narbel, J. P. Hansen and J.R. Lien, Springer
• Fundamentals of Renewable Energy Processes 3rd Edition, A.V. da Rosa, Academic Press

Acknowledgement: *"Co-funded by the ERASMUS+ Programme of the European Union" (Contract number: 101004049 — EURECA-PRO — EAC-A02-2019 / EAC-A02-2019-1)*

# COURSE OUTLINE

## 1. COURSE INFORMATION

| | | | |
|---|---|---|---|
| **SCHOOL** | Mineral Resources Engineering | | |
| **DEPARTMENT** | Mineral Resources Engineering | | |
| **COURSE LEVEL** | Graduate | | |
| **COURSE ID** | | **SEMESTER** | Spring |
| **COURSE TITLE** | Emerging technologies for the exploration of raw materials | | |

| **COURSE MODULES** *in the case of credits being awarded in distinct parts of the course eg. Lectures, Laboratory Exercises, etc. If credit units are awarded uniformly for the whole course, indicate the weekly hours of teaching and the total number of credits.* | **INSTRUCTION HOURS PER WEEK** | **CREDITS** |
|---|---|---|
| Lectures | 3 | |
| Tutorial Exercises/Laboratories | | |
| | | |
| **Total** | | 10 |
| *Add rows if needed. The teaching organization and teaching methods used are described in detail in (4).* | | |

| | |
|---|---|
| **COURSE TYPE** *Background, General Knowledge, Scientific Area, Skills Development* | General background |
| **PREREQUISITES:** | |
| **INSTRUCTION/EXAM LANGUAGE:** | English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS:** | Yes |
| **COURSE URL:** | EURECA PRO LMS Moodle URL: https://moodle.eurecapro.tuc.gr/course/view.php?id=136 |

## 2. LEARNING OUTCOMES

*The learning outcomes of the course describe the specific knowledge, skills and competences of an appropriate level that students will acquire after successfully completing the course.*

*Refer to Appendix A.*

- *Description of the Level of Learning Outcomes for each course of study in line with the European Higher Education Area Qualifications Framework*
- *Descriptive Indicators of Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Annex B*
- *Learning Outcomes Writing Guide*

After completing this course the student will be able to perform:

- Analyse images
- Apply image based analysis
- Solve exploration challenges using geophysical methods
- Value the capabilities and limitations of geophysical data types
- Compose geostatistical data analysis
- Demonstrate Simulation methods
- Evaluate Uncertainties

**General Competencies/Skills**

*Considering the general competencies that the graduate must have acquired (as listed in the Diploma Supplement and below), which one(s) the course enhances?*

*Search, analysis and synthesis of data and information, using the necessary technologies*
*Adaptation to new situations*
*Decision making*
*Autonomous work*
*Teamwork*
*Project design and management*
*Respect for diversity and multiculturalism*
*Respect for the natural environment*
*Demonstration of social, professional and moral responsibility and sensitivity to gender issues*
*Exercise criticism and self-criticism*

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| | |
|---|---|
| *Working in an international environment*<br>*Working in an interdisciplinary environment*<br>*Production of new research ideas* | *Promoting free, creative and inductive thinking* |

- Research, analysis and synthesis of data and information, using the necessary technologies
- Adapting to new situations
- Decision-making
- Autonomous work
- Production of new research ideas
- Exercise of criticism and self-criticism
- Promoting free, creative and inductive thinking
- Written communication
- Oral communication
- Alternative/ Innovative Thinking
- Time Management
- Determination
- Computer Skill
- Problem Solving
- Work in interdisciplinary environment

## 3. COURSE SYLLABUS

**Week 1.** Introduction to image analysis
**Week 2.** Image enhancement
**Week 3-4.** Image analysis
**Week 5.** Convolutional Neural Networks
**Week 6.** Introduction to geophysical methods
**Week 7.** Gravity and magnetic methods
**Week 8.** Electrical and electromagnetic methods
**Week 9.** Data acquisition, enhancement and interpretation
**Week 10-11.** Spatial/spatiotemporal geostatistical analysis principles
**Week 12.** Conditional Simulation methods
**Week 13.** Uncertainty propagation

## 4. TEACHING and LEARNING METHODS – ASSESSMENT

| | |
|---|---|
| **LECTURE METHOD**<br>*Face to face, distance learning, etc.* | Face to Face/distance learning |
| **USE OF INFORMATION AND COMMUNICATION TECHNOLOGY**<br>*Use of ICT in Teaching, in Laboratory Exercises, in Communication with students* | In Teaching:<br>- PC<br>- eclass<br>- web Apps<br>In Laboratory/Tutorials Education:<br>- PC<br>- eclass<br>- moodle<br>In Communication with Students:<br>- PC<br>- eclass |

**TEACHING ORGANISATION**

*Describe in detail the way and methods of teaching.*
*Lectures, Seminars, Laboratory Exercise, Field Exercise, Literature review & analysis, Tutoring, Practice (Placement), Clinical Exercise, Artistic Lab, Interactive teaching, Educational visits, Project work, project, etc.*

| ***ACTIVITY*** | ***Workload per semester (in Hours)*** |
|---|---|
| Lectures | 38 hours |
| Laboratories | 12 hours |
| Tutorials | 15 hours |
| Laboratories/Tutorials | 15 hours |
| Individual Project | 60 hours |
| Research/ Stud | 40 hours |
| Self Studies | 40 hours |

| | | | |
|---|---|---|---|
| *The student's study hours for each learning activity and the hours of non-guided study according to the ECTS principles are mentioned.* | Literature Review | 30 hours | |
| | ***Course Total (25 hours' workload/ECTS credit)*** | ***250*** | |
| **ASSESSMENT METHODS**<br>*Description of the evaluation process*<br><br>*Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Public Presentation, Laboratory Assignment, Clinical Examination of Patients, Artistic Interpretation, Other*<br><br>*Well defined student assessment criteria are mentioned. Mention whether and how the students can access them.* | Written Final Examination | 40% | (Multiple Choice Questions / Matching)<br>(Comparative evaluation of theoretical issues)<br>(Short answer questions)<br>(Problem solving questions) |
| | Individual Project | 30% | (Public Presentation)<br>(Oral Exam)<br>(Project Score) |
| | Tutorial/lab projects | 30% | (Project Score) |

## 5. DIGITIZATION (use of tools & software)

- Matlab software
- Open source machine learning software
- R-studio (CRAN)
- E-Z Variogram analysis

## 6. RECOMMENDED INTERNATIONAL LITERATURE


- Digital Image Processing by Rafael Gonzalez, Richard Woods
- Geophysics for the Mineral Exploration Geoscientist by Michael Dentith, S.T. Mudge
- Varouchakis, Emmanouil A. "Geostatistics: mathematical and statistical basis.". Elsevier, 2019. 1-38.
- Varouchakis, E.A., 2019. 2 - Background of Spatiotemporal Geostatistical Analysis: In: Corzo, G., Varouchakis, E.A. (Eds.), Spatiotemporal Analysis of Extreme Hydrological Events. Elsevier, pp. 39-57.


Acknowledgement: *"Co-funded by the ERASMUS+ Programme of the European Union" (Contractnumber: 101004049 — EURECA-PRO — EAC-A02-2019 / EAC-A02-2019-1)*

# COURSE OUTLINE

## 1. COURSE INFORMATION

| | | | |
|---|---|---|---|
| **SCHOOL** | Chemical and Environmental Engineering | | |
| **DEPARTMENT** | | | |
| **COURSE LEVEL** | Master | | |
| **COURSE ID** | | **SEMESTER** | Spring |
| **COURSE TITLE** | Circular Economy | | |

| **COURSE MODULES** *in the case of credits being awarded in distinct parts of the course eg. Lectures, Laboratory Exercises, etc. If credit units are awarded uniformly for the whole course, indicate the weekly hours of teaching and the total number of credits.* | **INSTRUCTION HOURS PER WEEK** | **CREDITS** |
|---|---|---|
| Lectures | 3 | |
| Laboratories | 0 | |
| Tutorial Exercises | 0 | |
| **Total** | 39 | 9 |
| *Add rows if needed. The teaching organization and teaching methods used are described in detail in (4).* | | |

| | |
|---|---|
| **COURSE TYPE** *Background, General Knowledge, Scientific Area, Skills Development* | Background and general knowledge, Development of new skills, Management / Technology |
| **PREREQUISITES:** | none |
| **INSTRUCTION/EXAM LANGUAGE:** | English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS:** | yes |
| **COURSE URL:** | EURECA-PRO LMS URL: https://moodle.eurecapro.tuc.gr/course/view.php?id=137 |

## 2. LEARNING OUTCOMES

**Learning Outcomes**

*The learning outcomes of the course describe the specific knowledge, skills and competences of an appropriate level that students will acquire after successfully completing the course.*

*Refer to Appendix A.*

- *Description of the Level of Learning Outcomes for each course of study in line with the European Higher Education Area Qualifications Framework*
- *Descriptive Indicators of Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Annex B*
- *Learning Outcomes Writing Guide*

The course aims to present and analyze the basic principles and concept of Circular Economy. As a relatively new paradigm of economic development, Circular Economy is rapidly growing. The course will show how Circular Economy can be applied in practice, in which disciplines and areas, and the opportunities that provide for multi- and interdisciplinary collaboration. The course also aims at supporting the participant to carry out or reflect upon her/his research and study with a transdisciplinary approach. Emphasis is put on:

- The environmental problems and issues that led to the need for paradigm shift
- The relation and interconnection between sustainability and circularity
- The basic principles and approach of circular economy
- The adoption of circularity in the business sector and the industry

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- The change in mindset and way of thinking

The benefits of circular economy for the users, the economy, the society and the businesses

**General Competencies/Skills**

*Considering the general competencies that the graduate must have acquired (as listed in the Diploma Supplement and below), which one(s) the course enhances?*

*Search, analysis and synthesis of data and information, using the necessary technologies*
*Adaptation to new situations*
*Decision making*
*Autonomous work*
*Teamwork*
*Working in an international environment*
*Working in an interdisciplinary environment*
*Production of new research ideas*
*Project design and management*
*Respect for diversity and multiculturalism*
*Respect for the natural environment*
*Demonstration of social, professional and moral responsibility and sensitivity to gender issues*
*Exercise criticism and self-criticism*
*Promoting free, creative and inductive thinking*

Successfully evaluate issues and challenges related with:

- Understand the concept of circular economy and its differences and connection to sustainable development
- Adopt circular practices and changes across different sectors and fields

## 3. COURSE SYLLABUS

**Week 1:** Introduction to the Circular Economy – Class Overview
**Week 2:** Sustainable growth and Circular Economy
**Week 3:** Circular Economy Principles
**Week 4:** Waste and Systems-Level Thinking
**Week 5:** Enterprise Environmental Performance - Environmental Management Systems (Part I)
**Week 6:** Green Entrepreneurship & Financing
**Week 7:** Environmental Management & Policy
**Week 8:** Enterprise Environmental Performance - Environmental Management Systems (Part II)
**Week 9:** Enterprise Environmental Performance & Environmental Practices
**Week 10:** Material and Product Design
**Week 11:** Environmental Quality Assurance Techniques
**Week 12:** Circular Economy at the Urban and Regional Level - Case Studies
**Week 13:** Project presentations by students

## 4. TEACHING and LEARNING METHODS – ASSESSMENT

| | |
|---|---|
| **LECTURE METHOD**<br>*Face to face, distance learning, etc.* | Virtual |
| **USE OF INFORMATION AND COMMUNICATION TECHNOLOGY**<br>*Use of ICT in Teaching, in Laboratory Exercises, in Communication with students* | Powerpoint presentations, videos and e-class support |
| **TEACHING ORGANISATION**<br>*Describe in detail the way and methods of teaching.*<br>*Lectures, Seminars, Laboratory Exercise, Field Exercise, Literature review & analysis, Tutoring, Practice (Placement), Clinical Exercise, Artistic Lab, Interactive teaching, Educational visits, Project work, project, etc.*<br>*The student's study hours for each learning activity and the hours of non-guided study according to the ECTS principles are mentioned.* | |

| ***ACTIVITY*** | ***Workload per semester (in Hours)*** |
|---|---|
| Lectures | 39 |
| Tutorials | |
| Lab assignments | |
| Projects | 100 |
| Autonomous study | 120 |
| ***Course Total (25 hours workload/ECTS credit)*** | ***259*** |

| | |
|---|---|
| **ASSESSMENT METHODS**<br>*Description of the evaluation process* | Project (100%) |

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| | |
|---|---|
| *Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Public Presentation, Laboratory Assignment, Clinical Examination of Patients, Artistic Interpretation, Other*<br><br>*Well defined student assessment criteria are mentioned. Mention whether and how the students can access them.* | |

## 5. DIGITIZATION (use of tools & software)

| |
|---|
| |

## 6. RECOMMENDED INTERNATIONAL LITERATURE


| |
|---|
| • Ellen MacArthur Foundation, "Towards the Circular Economy: Economic and Business Rationale for an Accelerated Transition," 2013. Executive Summary.<br>• Stefanakis, A.I. and Nikolaou, I., 2021. Circular Economy and Sustainability - Management and Policy, Volumes I & II. Elsevier Publishing, Amsterdam, The Netherlands, September.<br>• A. Wijkman and K. Skanberg, "The Circular Economy and Benefits for Society," Sections 2 and 4, 2015<br>• Ellen MacArthur Foundation, "Completing the picture – How the Circular Economy tackles climate change", September 2019.<br>• Lieder, M., & Rashid, A. (2016). Towards circular economy implementation: a comprehensive review in context of manufacturing industry. Journal of Cleaner Production, 115, 36-51. https://doi.org/10.1016/j.jclepro.2015.12.042 |


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# COURSE OUTLINE

## 1. COURSE INFORMATION

| | | | |
|---|---|---|---|
| **SCHOOL** | Chemical and Environmental Engineering | | |
| **DEPARTMENT** | Chemical and Environmental Engineering | | |
| **COURSE LEVEL** | Postgraduate | | |
| **COURSE ID** | B-214 | **SEMESTER** | Spring |
| **COURSE TITLE** | Air pollution – Fundamentals and Practice | | |

| **COURSE MODULES** *in the case of credits being awarded in distinct parts of the course eg. Lectures, Laboratory Exercises, etc. If credit units are awarded uniformly for the whole course, indicate the weekly hours of teaching and the total number of credits.* | **INSTRUCTION HOURS PER WEEK** | **CREDITS (ECTS)** |
|---|---|---|
| Lectures | 3 | 9 |
| Laboratories | | |
| Tutorial Exercises | | |
| **Total** | **3** | **9** |
| *Add rows if needed. The teaching organization and teaching methods used are described in detail in (4).* | | |

| | |
|---|---|
| **COURSE TYPE** *Background, General Knowledge, Scientific Area, Skills Development* | Background, General Knowledge, also delving into specific topics related to air pollution modeling and policy aspects. |
| **PREREQUISITES:** | None |
| **INSTRUCTION/EXAM LANGUAGE:** | English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS:** | Yes |
| **COURSE URL:** | EURECA PRO LMS Moodle URL: https://moodle.eurecapro.tuc.gr/course/view.php?id=138 |

## 2. LEARNING OUTCOMES

**Learning Outcomes**

*The learning outcomes of the course describe the specific knowledge, skills and competences of an appropriate level that students will acquire after successfully completing the course.*

*Refer to Appendix A.*

- *Description of the Level of Learning Outcomes for each course of study in line with the European Higher Education Area Qualifications Framework*
- *Descriptive Indicators of Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Annex B*
- *Learning Outcomes Writing Guide*

After completing this course the student will be able to:

- Understand the problem of air pollution on different spatial and temporal scales.
- Know the sources of different types of air pollutants around the world.
- Be able to construct basic equations that predict the concentrations of air pollutants in the atmosphere.
- Understand the linkages between air pollution and climate change.
- Be familiar with measurement techniques used for monitoring air pollution.
- Have basic knowledge of how models predicting atmospheric pollution work.
- Have a grasp of policies that can improve air quality levels while also benefiting our climate.

**General Competencies/Skills**

| *Considering the general competencies that the graduate must have acquired (as listed in the Diploma Supplement and below), which one(s) the course enhances?* | |
|---|---|
| *Search, analysis and synthesis of data and information, using the necessary technologies*<br>*Adaptation to new situations*<br>*Decision making*<br>*Autonomous work*<br>*Teamwork*<br>*Working in an international environment*<br>*Working in an interdisciplinary environment*<br>*Production of new research ideas* | *Project design and management*<br>*Respect for diversity and multiculturalism*<br>*Respect for the natural environment*<br>*Demonstration of social, professional and moral responsibility and sensitivity to gender issues*<br>*Exercise criticism and self-criticism*<br>*Promoting free, creative and inductive thinking* |
| All of the above | |

## 3. COURSE SYLLABUS

1. Overview of the air pollution problem – history and current state
2. Gaseous pollutants
3. Aerosol pollutants
4. Air pollutants and climate change
5. Modelling air pollution and air quality
6. Problem class
7. Measuring air pollution and air quality
8. Health and ecosystem effects of air pollution
9. Effects of weather phenomena on air pollutants
10. Air quality control policies and regulations
11. Indoor air quality / Project overview
12. Modelling dispersion of pollutants / Project progress
13. Project presentations

## 4. TEACHING and LEARNING METHODS – ASSESSMENT

| | |
|---|---|
| **LECTURE METHOD**<br>*Face to face, distance learning, etc.* | Hybrid |
| **USE OF INFORMATION AND COMMUNICATION TECHNOLOGY**<br>*Use of ICT in Teaching, in Laboratory Exercises, in Communication with students* | Use of Eclass for course organization, Zoom for delivery to remote attendants, and Moodle for course examination. |
| **TEACHING ORGANISATION**<br><br>*Describe in detail the way and methods of teaching.*<br>*Lectures, Seminars, Laboratory Exercise, Field Exercise, Literature review & analysis, Tutoring, Practice (Placement), Clinical Exercise, Artistic Lab, Interactive teaching, Educational visits, Project work, project, etc.*<br><br>*The student's study hours for each learning activity and the hours of non-guided study according to the ECTS principles are mentioned.* | |

| ***ACTIVITY*** | ***Workload per semester (in Hours)*** |
|---|---|
| Lectures | 40 |
| Tutorials | |
| Lab assignments | |
| Projects | 50 |
| Autonomous study | 135 |
| | |
| | |
| | |
| ***Course Total (25 hours' workload/ECTS credit)*** | ***9 ECTS overall*** |

| | |
|---|---|
| **ASSESSMENT METHODS**<br>*Description of the evaluation process*<br><br>*Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development* | The language of assessment is English.<br><br>Assessment constitutes of two parts:<br>1) Project<br>2) Final examination |

| | |
|---|---|
| *Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Public Presentation, Laboratory Assignment, Clinical Examination of Patients, Artistic Interpretation, Other*<br><br>*Well defined student assessment criteria are mentioned. Mention whether and how the students can access them.* | The two aspects of assessment count equally (50% + 50%) towards the final grade that the student will be awarded in the module.<br><br>The final exam constitutes of a quantitative problem that needs to be solved which relates to air pollutants in the atmosphere, along with multiple choice questions that test the understanding of key aspects of the module.<br><br>The project will be on a topic that will be mutually decided by the professor and the students, and will involve presenting a real-world problem related to air pollution, potentially also with aspects of how the problem can be solved. |

## 5. DIGITIZATION (use of tools & software)

- Eclass
- Moodle
- Zoom

## 6. RECOMMENDED INTERNATIONAL LITERATURE


- Mark Z. Jacobson (2012), "Air Pollution and Global Warming: History, Science, and Solutions", Cambridge University Press

- Lazaridis, M. (2010), "First Principles of Meteorology and Air Pollution", Springer


Acknowledgement: *"Co-funded by the ERASMUS+ Programme of the European Union" (Contractnumber: 101004049 — EURECA-PRO — EAC-A02-2019 / EAC-A02-2019-1)*

# COURSE OUTLINE

## 1. COURSE INFORMATION

| | | | | |
|---|---|---|---|---|
| **SCHOOL** | School of Chemical and Environmental Engineering | | | |
| **DEPARTMENT** | | | | |
| **COURSE LEVEL** | Postgraduate | | | |
| **COURSE ID** | **A104** | **SEMESTER** | Spring | |
| **COURSE TITLE** | Advanced Oxidation Processes for Water and Wastewater Treatment | | | |
| **COURSE MODULES** *in the case of credits being awarded in distinct parts of the course eg. Lectures, Laboratory Exercises, etc. If credit units are awarded uniformly for the whole course, indicate the weekly hours of teaching and the total number of credits.* | | | **INSTRUCTION HOURS PER WEEK** | **CREDITS** |
| | Lectures | | 3 | |
| | Laboratories | | | |
| | Tutorial Exercises | | | |
| | **Total** | | 3 | 9 |
| *Add rows if needed. The teaching organization and teaching methods used are described in detail in (4).* | | | | |
| **COURSE TYPE** *Background, General Knowledge, Scientific Area, Skills Development* | General Background | | | |
| **PREREQUISITES:** | - | | | |
| **INSTRUCTION/EXAM LANGUAGE:** | English | | | |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS:** | Yes | | | |
| **COURSE URL:** | EURECA PRO LMS Moodle URL: https://moodle.eurecapro.tuc.gr/course/view.php?id=139 | | | |

## 2. LEARNING OUTCOMES

**Learning Outcomes**

*The learning outcomes of the course describe the specific knowledge, skills and competences of an appropriate level that students will acquire after successfully completing the course.*

*Refer to Appendix A.*

- *Description of the Level of Learning Outcomes for each course of study in line with the European Higher Education Area Qualifications Framework*
- *Descriptive Indicators of Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Annex B*
- *Learning Outcomes Writing Guide*

After completing this course the student will be able to:

- Analyze experimental results published in the literature regarding the application of advanced oxidation processes for water and wastewater treatment
- Choose the most efficient method(s) for water and wastewater treatment
- Collect data published in the scientific literature concerning water pollution and advanced oxidation processes for water and wastewater treatment
- Compare the efficiency of the various advanced oxidation processes for the degradation of organic pollutants in aqueous matrices
- Comprehend the fundamental target of advanced oxidation processes for water and wastewater treatment
- Describe the general methods used for water and wastewater treatment
- Evaluate the various advanced oxidation processes in terms of their reactivity towards the

degradation of organic pollutants in the aqueous phase
- Explain the basic mechanism of the various advanced oxidation processes
- Propose appropriate advanced oxidation processes for the degradation of various classes of organic pollutants
- Recognize the main advantages and disadvantages of the advanced oxidation processes
- Relate the structure of various organic pollutants with their reactivity towards advanced oxidation processes
- Review the basic principles of advanced oxidation processes
- Select the most efficient advanced oxidation processes in terms of their energy consumption and cost
- Use the knowledge gained in the course regarding advanced oxidation processes for large scale applications
- Design a treatment train for water and wastewater

**General Competencies/Skills**

*Considering the general competencies that the graduate must have acquired (as listed in the Diploma Supplement and below), which one(s) the course enhances?*

*Search, analysis and synthesis of data and information, using the necessary technologies*
*Adaptation to new situations*
*Decision making*
*Autonomous work*
*Teamwork*
*Working in an international environment*
*Working in an interdisciplinary environment*
*Production of new research ideas*
*Project design and management*
*Respect for diversity and multiculturalism*
*Respect for the natural environment*
*Demonstration of social, professional and moral responsibility and sensitivity to gender issues*
*Exercise criticism and self-criticism*
*Promoting free, creative and inductive thinking*

- Search, analysis and synthesis of data and information, using the necessary technologies
- Adaptation to new situations
- Decision-making
- Autonomous work
- Teamwork
- Working in an international environment
- Working in an interdisciplinary environment
- Respect for the natural environment
- Promoting free, creative and inductive thinking
- Written communication
- Oral communication
- Alternative/Innovative Thinking
- Problem Solving

## 3. COURSE SYLLABUS

1. Water pollution
2. Water and wastewater treatment
3. Overview of Advanced Oxidation Processes (AOPs)
4. Redox reactions and electrochemical processes
5. UV photolysis, Part I
6. UV photolysis, Part II
7. UV/$H_2O_2$ processes
8. Ozone in water and wastewater treatment, Part I
9. Ozone in water and wastewater treatment, Part II
10. Ozone in water and wastewater treatment, Part III
11. Fenton-based processes, Part I
12. Fenton-based processes, Part II
13. Fenton-based processes, Part III

## 4. TEACHING and LEARNING METHODS – ASSESSMENT

| | |
|---|---|
| **LECTURE METHOD**<br>*Face to face, distance learning, etc.* | Direct (face to face) and distance learning |
| **USE OF INFORMATION AND COMMUNICATION TECHNOLOGY**<br>*Use of ICT in Teaching, in Laboratory Exercises, in Communication with students* | • Power point presentations<br>• E-class support |
| **TEACHING ORGANISATION**<br>*Describe in detail the way and methods of teaching.*<br>*Lectures, Seminars, Laboratory Exercise, Field Exercise, Literature review & analysis, Tutoring, Practice (Placement), Clinical Exercise, Artistic Lab, Interactive teaching, Educational visits, Project work, project, etc.*<br>*The student's study hours for each learning activity and the hours of non-guided study according to the ECTS principles are mentioned.* | |

| ***ACTIVITY*** | ***Workload per semester (in Hours)*** |
|---|---|
| Lectures | 39 |
| Tutorials | |
| Lab assignments | |
| Projects | 100 |
| Autonomous study | 86 |
| | |
| | |
| | |
| ***Course Total (25 hours' workload/ECTS credit)*** | ***225*** |

| | |
|---|---|
| **ASSESSMENT METHODS**<br>*Description of the evaluation process*<br>*Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Public Presentation, Laboratory Assignment, Clinical Examination of Patients, Artistic Interpretation, Other well defined student assessment criteria are mentioned. Mention whether and how the students can access them.* | Assessment Language: English<br>Assessment Method: Individual project including public presentation and oral examination.<br>Summative assessment: students will receive a grade (score) indicating their overall performance during project preparation, presentation and oral examination. |

## 5. DIGITIZATION (use of tools & software)

Eclass, Moodle, Zoom

## 6. RECOMMENDED INTERNATIONAL LITERATURE


- Advanced Oxidation Processes for Water Treatment, Edited by: Mihaela Stefan, IWA Publishing, 2017, ISBN: 9781780407180. https://doi.org/10.2166/9781780407197
- Advanced Oxidation Processes for Water and Wastewater Treatment, Edited by: Simon Parsons, IWA Publishing, 2004, ISBN: 9781843390176. https://doi.org/10.2166/9781780403076
- Advanced Oxidation Processes for Wastewater Treatment, Edited by: Suresh Ameta, Rakshit Ameta, Academic Press, 2018, ISBN: 9780128104996. https://doi.org/10.1016/C2016-0-00384-4
- Chemistry of Ozone in Water and Wastewater Treatment, by Clemens von Sonntag, Urs von Gunten, IWA Publishing, 2012, ISBN: 9781843393139. https://doi.org/10.2166/9781780400839
- Water Treatment, Principles and Design, by Crittenden, Trussell, Hand, Howe, Tchobanoglous, John Wiley & Sons, 3rd Edition, 2012, ISBN: 9780470405390. https://doi.org/10.1002/9781118131473
- Wastewater Engineering: Treatment and Resource Recovery, by Tchobanoglous, Stensel, Tsuchihashi, Burton, McGraw Hill, 5th Edition, 2013, ISBN: 9780073401188.


Acknowledgement: *"Co-funded by the ERASMUS+ Programme of the European Union" (Contractnumber: 101004049 — EURECA-PRO — EAC-A02-2019 / EAC-A02-2019-1)*

# COURSE OUTLINE

## 1. COURSE INFORMATION

| | | | |
|---|---|---|---|
| **SCHOOL** | Chemical ad Environmental Engineering | | |
| **DEPARTMENT** | | | |
| **COURSE LEVEL** | Postgraduate | | |
| **COURSE ID** | | **SEMESTER** | Spring |
| **COURSE TITLE** | Climate Change Impact Assessment | | |
| **COURSE MODULES** *in the case of credits being awarded in distinct parts of the course eg. Lectures, Laboratory Exercises, etc. If credit units are awarded uniformly for the whole course, indicate the weekly hours of teaching and the total number of credits.* | | **INSTRUCTION HOURS PER WEEK** | **CREDITS** |
| Lectures and Tutorials | | 3 | 9 |
| *Add rows if needed. The teaching organization and teaching methods used are described in detail in (4).* | | | |
| **COURSE TYPE** *Background, General Knowledge, Scientific Area, Skills Development* | Special Background and Skills Development | | |
| **PREREQUISITES:** | There are no prerequisite courses.<br>The student is expected to have an adequate background on mathematics, physics/engineering, and basic skills on data processing (e.g. basic operations in excel).<br>Some familiarity with programming (standard equivalent to a first-year science undergraduate programming module) and GIS would be advantageous but is not essential. | | |
| **INSTRUCTION/EXAM LANGUAGE:** | English | | |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS:** | Yes | | |
| **COURSE URL:** | EURECA PRO LMS Moodle URL: https://moodle.eurecapro.tuc.gr/course/view.php?id=140 | | |

## 2. LEARNING OUTCOMES

**Learning Outcomes**

*The learning outcomes of the course describe the specific knowledge, skills and competences of an appropriate level that students will acquire after successfully completing the course.*

*Refer to Appendix A.*

- *Description of the Level of Learning Outcomes for each course of study in line with the European Higher Education Area Qualifications Framework*
- *Descriptive Indicators of Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Annex B*
- *Learning Outcomes Writing Guide*

After completing this course, the student will be able to:

Knowledge & Understanding:

- Comprehend the foundational concepts of climate science and the implications of a changing climate on both global and localized scales.
- Understanding key methodologies and principles of climate change impact assessment.
- Dissect and comprehend IPCC statements, reports, and findings.

Practical & Technical Skills:

- Source, extract, and interpret fit-for-purpose climate data for impact assessments, using a variety of tools and platforms.

- Apply hands-on techniques such as downscaling, adjustment, and processing of climate data to predict potential impacts.

Analytical & Problem-Solving Skills:

- Design and execute a CCIA project, from initial brainstorming to final presentation, integrating observational data, model outputs, and real-world applications.

Communication & Presentation Skills:

- Communicate scientific findings clearly and effectively.
- Present research projects coherently, integrating data, analyses, and implications into a structured presentation.

**General Competencies/Skills**

*Considering the general competencies that the graduate must have acquired (as listed in the Diploma Supplement and below), which one(s) the course enhances?*

*Search, analysis and synthesis of data and information, using the necessary technologies*
*Adaptation to new situations*
*Decision making*
*Autonomous work*
*Teamwork*
*Working in an international environment*
*Working in an interdisciplinary environment*
*Production of new research ideas*
*Project design and management*
*Respect for diversity and multiculturalism*
*Respect for the natural environment*
*Demonstration of social, professional and moral responsibility and sensitivity to gender issues*
*Exercise criticism and self-criticism*
*Promoting free, creative and inductive thinking*

- Search, analysis and synthesis of data and information, using the necessary technologies.
- Promoting free, creative and inductive thinking.
- Autonomous work.
- Working in an interdisciplinary environment.
- Awareness of the importance of the natural environment.

## 3. COURSE SYLLABUS

The CCIA course delves deep into the multifaceted effects of climate change on natural and human systems. Recognizing the gravity of current global climate challenges, the course equips students with the necessary tools and methodologies to evaluate the potential consequences of a changing climate on various sectors, such as agriculture, water resources, health, and urban planning. It combines scientific understanding with practical implications, focusing on both qualitative and quantitative assessment techniques. Students will learn the importance of local and global scale assessments, as well as the integration of socio-economic scenarios with climate change projections. Emphasis will be given to vulnerability and adaptation strategies, recognizing that climate change impact assessment is not only about understanding consequences but also preparing for them. Through a blend of theoretical knowledge, case studies, and hands-on exercises, learners will be well-prepared to contribute constructively to the climate change discourse and action plans in academic, governmental, or private sectors.

**Syllabus:**

| | |
|---|---|
| **1st Week:** | Introduction to climate change and impact modelling. |
| **2nd Week:** | The IPCC organization and the 6th assessment report on impacts adaptation and vulnerability. AR6 Interactive session: Find your own meaning in a Headline Statement<br>1st Assignment: delve into an IPCC Headline Statement (group assignment) |
| **3rd Week:** | Key concepts for Assessing Climate Change Impact.<br>Presentation of the 1st assignment |
| **4th Week:** | Climate Change Impacts: A Global and European Perspective<br>The IPCC interactive Atlas.<br>2nd Assignment: IPCC WG1 AR6 Interactive ATLAS (individual assignment) |
| **5th Week:** | Climate Change Impacts: A local scale Perspective<br>Presentation of the 2nd assignment |

| | |
|---|---|
| **6th Week:** | CCIA Projects Prospectus, roundtable discussion<br>3rd Assignment: Interpreting Climate Science: A Journal Paper Presentation (group assignment) |
| **7th Week:** | Climate model data: Sources, formats, software and repositories. The Copernicus Climate Data Store. Hands-on 1: Obtaining fit-for-purpose data for impact assessment. |
| **8th Week:** | Hands-on 2: The Climate Data Operator (CDO), installation |
| **9th Week:** | Hands-on 3: The Climate Data Operator (CDO), basic operations |
| **10th Week:** | Hands-on 4: Processing data for impact assessments (downscaling and impact modelling) |
| **11th Week:** | Presentation of the 3rd assignment |
| **12th Week:** | Detection and Attribution of Climate Change impacts |
| **13th Week:** | Project presentations and discussion |

## 4. TEACHING and LEARNING METHODS – ASSESSMENT

| | |
|---|---|
| **LECTURE METHOD**<br>*Face to face, distance learning, etc.* | Hybrid (Face to face and Distance learning) |
| **USE OF INFORMATION AND COMMUNICATION TECHNOLOGY**<br>*Use of ICT in Teaching, in Laboratory Exercises, in Communication with students* | • Moodle learning platform<br>• Zoom communication platform |
| **TEACHING ORGANISATION**<br>*Describe in detail the way and methods of teaching.*<br>*Lectures, Seminars, Laboratory Exercise, Field Exercise, Literature review & analysis, Tutoring, Practice (Placement), Clinical Exercise, Artistic Lab, Interactive teaching, Educational visits, Project work, project, etc.*<br>*The student's study hours for each learning activity and the hours of non-guided study according to the ECTS principles are mentioned.* | |

| ***ACTIVITY*** | ***Workload per semester (in Hours)*** |
|---|---|
| Lectures | 30 |
| Practical classes and workshops | 9 |
| Autonomous study | 58 |
| Assignments/tasks | 62 |
| Projects | 66 |
| ***Course Total (25 hours' workload/ECTS credit)*** | ***225*** |

| | |
|---|---|
| **ASSESSMENT METHODS**<br>*Description of the evaluation process*<br>*Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Public Presentation, Laboratory Assignment, Clinical Examination of Patients, Artistic Interpretation, Other*<br>*Well defined student assessment criteria are mentioned. Mention whether and how the students can access them.* | Assignments (40%)<br>Final project report (40%)<br>Project presentation and discussion (20%) |

## 5. DIGITIZATION (use of tools & software)

- Climate Data Operator (CDO)
- Data processing and analysis software

## 6. RECOMMENDED INTERNATIONAL LITERATURE

Zhongming, Z., Linong, L., Xiaona, Y., Wangqiang, Z., & Wei, L. (2021). AR6 climate change 2021: The physical science basis.

Pörtner, H. O., Roberts, D. C., Adams, H., Adler, C., Aldunce, P., Ali, E., ... & Fischlin, A. (2022). Climate change 2022: Impacts, adaptation and vulnerability. IPCC Sixth Assessment Report.

Feenstra, J. F., Burton, I., Smith, J. B., & Tol, R. S. (1998). Handbook on methods for climate change impact assessment and adaptation strategies.

Parry, M., Nishioka, S., Harasawa, H., & Carter, T. (1996). Technical guidelines for assessing climate change impacts and adaptations.

Further readings of selected material as indicated in the individual lecture presentations (reports and scientific publications).

Acknowledgement: *"Co-funded by the ERASMUS+ Programme of the European Union"*
*(Contract number: 101004049 — EURECA-PRO — EAC-A02-2019 / EAC-A02-2019-1)*

# COURSE OUTLINE

## 1. COURSE INFORMATION

| | | | |
|---|---|---|---|
| **SCHOOL** | Architecture | | |
| **DEPARTMENT** | Architecture | | |
| **COURSE LEVEL** | Graduate | | |
| **COURSE ID** | | **SEMESTER** | Winter |
| **COURSE TITLE** | Decay and Conservation of Construction Materials of Monuments and Architectural Surfaces | | |

| **COURSE MODULES** *in the case of credits being awarded in distinct parts of the course eg. Lectures, Laboratory Exercises, etc. If credit units are awarded uniformly for the whole course, indicate the weekly hours of teaching and the total number of credits.* | **INSTRUCTION HOURS PER WEEK** | **CREDITS** |
|---|---|---|
| Lectures | 2 | |
| Laboratories | 1 | |
| Tutorial Exercises | | |
| **Total** | 3 | 6 |
| *Add rows if needed. The teaching organization and teaching methods used are described in detail in (4).* | | |

| | |
|---|---|
| **COURSE TYPE** *Background, General Knowledge, Scientific Area, Skills Development* | General knowledge |
| **PREREQUISITES:** | None |
| **INSTRUCTION/EXAM LANGUAGE:** | English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS:** | No |
| **COURSE URL:** | EURECA PRO LMS Moodle URL: https://moodle.eurecapro.tuc.gr/course/view.php?id=88 |

## 2. LEARNING OUTCOMES

**Learning Outcomes**

*The learning outcomes of the course describe the specific knowledge, skills and competences of an appropriate level that students will acquire after successfully completing the course.*

*Refer to Appendix A.*

- *Description of the Level of Learning Outcomes for each course of study in line with the European Higher Education Area Qualifications Framework*
- *Descriptive Indicators of Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Annex B*
- *Learning Outcomes Writing Guide*

After completing this course, the student will be able to:
- to identify the decay patterns that were observed on the monumental and architectural surfaces
-to correlate the decay forms with the main environmental factors that are responsible for their formation
-to document the decay patterns and the different construction materials
-to propose materials and techniques for the conservation of the architectural surfaces
-to understand the compatibility and sustainability of historic construction materials
-to propose low energetic demanded materials and techniques for the conservation of the architectural surfaces
- to implement measures of conservation and plan further appropriate steps in collaboration with specialists in this sector

**General Competencies/Skills**

*Considering the general competencies that the graduate must have acquired (as listed in the Diploma Supplement and below), which one(s) the course enhances?*

| | |
|---|---|
| *Search, analysis and synthesis of data and information, using the necessary technologies* | *Project design and management* |
| *Adaptation to new situations* | *Respect for diversity and multiculturalism* |
| *Decision making* | *Respect for the natural environment* |
| | *Demonstration of social, professional and moral responsibility and sensitivity to gender* |

Co-funded by the Erasmus+ Programme of the European Union

| | |
|---|---|
| *Autonomous work*<br>*Teamwork*<br>*Working in an international environment*<br>*Working in an interdisciplinary environment*<br>*Production of new research ideas* | *issues*<br>*Exercise criticism and self-criticism*<br>*Promoting free, creative and inductive thinking* |
| All of the above | |

## 3. COURSE SYLLABUS

Content: The above course combines causes and patterns of decay, which have been observed on construction materials of monuments and architectural surfaces; the course aims at studying the influence of the environmental parameters and the intrinsic properties of the materials in the whole condition of the monument and the architectural surface. The students first understand the concepts of compatibility and resilience to weathering of building materials, in order to be able to direct both the maintenance and restoration of buildings in the future, as well as to prevent buildings and monuments from damage. Particular attention is also paid to the use of eco-friendly materials, such as e.g. lime and hydraulic lime, and their contribution to the sustainability and reduction of energy consumption of structures.
The above course develops an atlas, which is a recording tool with decay patterns based on macroscopic observation in order to better document the effect of the weathering on the materials and to correlate it with the main damage parameters, extrinsic and/or intrinsic. The course acts as complementary with courses dealing with the restoration of historic buildings, focusing on the study of the materials, their decay and corrosion, and methods of conservation.

Outline
1. Causes of damage to building materials: environmental, intrinsic, extrinsic
2. Atlas recording the decay patterns on buildings and monuments
3. Presence of water in porous building materials
4. Moisture and soluble salts in buildings and monuments
5. Natural materials in construction
6. Air- and Hydraulic-lime Mortars. Clay mortars
7. Breathable coatings and paints
8. Rising dump and remediation techniques
9. Cleaning of the architectural surfaces (mechanical, chemical and laser) and evaluation
10. Consolidants and protectives for the monuments and their evaluation

## 4. TEACHING and LEARNING METHODS – ASSESSMENT

| | |
|---|---|
| **LECTURE METHOD**<br>*Face to face, distance learning, etc.* | Distance learning, hybrid |
| **USE OF INFORMATION AND COMMUNICATION TECHNOLOGY**<br>*Use of ICT in Teaching, in Laboratory Exercises, in Communication with students* | Power point presentations, video |

**TEACHING ORGANISATION**

*Describe in detail the way and methods of teaching.*
*Lectures, Seminars, Laboratory Exercise, Field Exercise, Literature review & analysis, Tutoring, Practice (Placement), Clinical Exercise, Artistic Lab, Interactive teaching, Educational visits, Project work, project, etc.*

*The student's study hours for each learning activity and the hours of non-guided study according to the ECTS principles are mentioned.*

| ***ACTIVITY*** | ***Workload per semester (in Hours)*** |
|---|---|
| Lectures | 20 |
| Tutorials | 20 |
| Lab assignments | 10 |
| Projects | 30 |
| Autonomous study | 70 |
| ***Course Total (25 hours' workload/ECTS credit)*** | ***150*** |

| | |
|---|---|
| **ASSESSMENT METHODS**<br>*Description of the evaluation process.*<br>*Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Public Presentation, Laboratory Assignment, Clinical Examination of Patients, Artistic Interpretation, Other*<br>*Well defined student assessment criteria are mentioned. Mention whether and how the students can access them.* | Oral exams and presentation of the project implementation at the end of the semester |

## 5. DIGITIZATION (use of tools & software)

Software for:

- Fiber digital microscopy AM4515T8 Dino-Lite, 700-900x
- Fourier Transform Infrared Spectroscopy (FTIR) (Thermo Fisher ScientificWaltham, USA) absorption spectra. The spectra were recorded with a Thermo iS50 FTIR spectrometer (Thermo Fisher ScientificWaltham, USA), in the spectral range from 4.000 to 400 $cm^{-1}$.
- Raman module in the sample compartment of the Scientific Nicolet iS50 spectrometer (Thermo Fisher ScientificWaltham, USA) operating with a laser at 1064 nm.
- UV–VIS Perkin-Elmer Lambda 35 spectrophotometer (Perkin Elmer, Waltham, USA) equipped with a Labsphere RSA-PE 20
- Konica Minolta spectrophotometer CM-2600d adapted with a D65 illuminant at 8-degree viewing, in wavelength range from 360 to 740 nm

## 6. RECOMMENDED INTERNATIONAL LITERATURE

1. "Saving Our Architectural Heritage: The Conservation of Historic Stone Structures", edited by Baer, N., S. and R. Snethlage, Wiley, 1997.
2. "Stone Decay and Conservation", G. Amoroso and V. Fassina, Elsevier Science, Amsterdam, 1983.
3. Microclimate for Cultural Heritage, D. Camuffo, Elsevier, 1998.
4. "The Deterioration of Monuments", Special Issue, The Science of the Total Environment, vol. 167, 1995.
5. "Modern Analytical Methods in Art and Archaeology", E. Ciliberto and G. Spoto, Wiley, 2000.
6. Nano-products in the European Construction Industry, State of the Art, EC 2009.
7. Francesca Gherardi, Pagona Noni Maravelaki, Conserving Stone Heritage, Springer International Publishing, January 2022, DOI 10.1007/978-3-030-82942-1, ISBN 978-3-03-082941-4, 978-3-03-082942-1

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