COURSE OUTLINE

1. COURSE INFORMATION

SCHOOL	Technical University of Crete		
DEPARTMENT	Mineral Resources Engineering		
COURSE LEVEL	Graduate		
COURSE ID		**SEMESTER**	Winter / Spring
COURSE TITLE	Fundamentals of Mineral Processing		

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	
PBL	1	
Laboratories		
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*	Core elective
PREREQUISITES:	Mineral chemistry - mineralogy, Solid background in applied fluid mechanics
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=73

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:

- ✓ Design and analyze open/close comminution circuits
- ✓ Define and understand the fundamental principles of mineral processing
- ✓ Calculate the mass balances for mineral processing circuits
- ✓ Analyze and apply the main mineral processing methods, e.g. magnetic and gravity separation, flotation etc., in practical separation tests for various ores
- ✓ Evaluate the performance and efficiency of mineral processing operations
- ✓ Understand the basic principles of fluid particle interactions in the dilute and dense bed limits
- ✓ Design and analyze the operation of fluidized beds for mineral processing

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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
Promoting free, creative and inductive thinking
Technology assessment (economic, environmental, social)
Decision making
Teamwork
Working in an interdisciplinary environment
Production of new research ideas

3. COURSE SYLLABUS

Lecture 1: Introduction to mineral processing, particle size & particle size distribution, sieve analysis, screen types, industrial screening, mass balances, exercises
Lecture 2-3: Particle size distribution models, size reduction, comminution machines, exercises
Lecture 4: Open / close circuit operations, mass balances, exercises
Lecture 5-6: Liberation / degree of liberation, mineral processing circuits, mass balances, metal units, recovery, exercises
Lecture 7-8: Optical & magnetic separation, gravity separation, heavy media separation, types of concentrators, exercises
Lecture 9: Froth flotation, collectors, activation and depression mechanisms, flotation cells, flotation circuits, basic principles of settling and classification, exercises.
Lecture 10: Fundamentals of flow past solids- Fluid-solid interactions
Lecture 11: Introduction to the dynamics of fluidized beds
Lecture 12: Reaction Kinetics in fluidized beds
Lecture 13: Numerical simulation of fluidized beds using COMSOL Multiphysics – Hands on practice

4. TEACHING and LEARNING METHODS – ASSESSMENT

LECTURE METHOD *Face to face, distance learning, etc.*	Face to face, distant learning and PBL: the presence of students in all lectures is **obligatory**
USE OF INFORMATION AND COMMUNICATION TECHNOLOGY *Use of ICT in Teaching, in Laboratory Exercises, in Communication with students*	Microsoft Excel and Microsoft Powerpoint will be used during classes and project implementation.

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	26
Tutorials	
Lab assignments	
Projects	26
Autonomous study	98

The student's study hours for each learning activity and the hours of non-guided study according to the ECTS principles are mentioned.	***Course Total (25 hours' workload/ECTS credit)***	***150***
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.*	2 Projects per student (involving teamwork) through PBL. 20' presentation with a ppt file, Q&A: 60% A research article in a relevant topic will be prepared by each student. A ~3 page summary and ppt presentation will be prepared, involving critical analysis of the topic: 40%	

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

- Wills, B.A.; Finch, J.A. 2016. Wills Mineral Processing Technology: An Introduction to the Practical Aspects of Ore Treatment and Mineral Recovery, Butterworth-Heinemann Publishers, Oxford, UK.
- Fuerstenau, M.C.; Han, K.N. 2003. Principles of Mineral Processing, Society for Mining, Metallurgy, and Exploration, USA.
- Allen, T. 2003. Powder Sampling and Particle Size Determination; Elsevier: Amsterdam, The Netherlands.
- Petrakis, E.; Stamboliadis, E.; Komnitsas, K. 2017. Identification of optimal mill operating parameters during grinding of quartz with the use of population balance modeling. KONA Powder and Particle Journal 34, 213-223.
- Petrakis, E.; Komnitsas, K. 2019. Effect of energy input in a ball mill on dimensional properties of grinding products. Mining, Metallurgy & Exploration, 36 (4), 803-816.
- Petrakis E., Karmali V., Komnitsas K. 2021. Factors affecting nickel upgrade during selective grinding of low-grade limonitic laterites. Mineral Processing and Extractive Metallurgy, 130 (3), 192-201
- Petrakis, E.; Komnitsas, K. 2021. Development of a non-linear framework for the prediction of the particle size distribution of the grinding products. Mining, Metallurgy & Exploration, 38 (2), 1253-1266.
- Transport Phenomena, Revised 2nd Edition, R. Byron Bird, Warren E. Stewart, Edwin N. Lightfoot, WILEY
- Fluidized-Bed Reactors: Processes and Operating Conditions, John G. Yates and Paola Lettier, 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	Mineral Resources Engineering		
DEPARTMENT	Mineral Resources Engineering		
COURSE LEVEL	Graduate		
COURSE ID		**SEMESTER**	Spring
COURSE TITLE	Data Science for Exploration and Exploitation		

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	10
Tutorial Exercises/Laboratories	2	
Total		
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:	
COURSE URL:	EURECA PRO LMS Moodle URL: https://moodle.eurecapro.tuc.gr/course/view.php?id=74

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:

- Data input/output commands
- Use data variables
- Arithmetic operations, iterations, control structures, vectors and matrices, use of data files, subroutines and functions

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 *Working in an interdisciplinary environment* *Production of new research ideas*	*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
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

3. COURSE SYLLABUS

Content

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

	- moodle In Communication with Students: - PC - 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.

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/labs	26
Tutorials/lab assignments	30
Projects	60
Autonomous study	50
Literature Review	45
	250
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.

Written Final Examination 40%
(Multiple Choice Questions / Matching)
(Comparative evaluation of theoretical issues)
(Short answer questions)
(Problem solving questions)

Individual Project 30%
(Public Presentation)
(Oral Exam)
(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	Mineral Resources Engineering		
DEPARTMENT	Mineral Resources Engineering		
COURSE LEVEL	Post-Graduate		
COURSE ID	**ST021**	**SEMESTER**	Spring
COURSE TITLE	Instrumental Analysis for 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	
Laboratories	0	
Tutorial Exercises	0	
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*	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=75

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.

After completing this course the student will be able to:

- Compare (Evaluate) various analytical methods.
- Recognize the advantages and disadvantages of various analytical techniques.
- Explain the difficulties arising during instrumental chemical analysis.
- Select to choose the most appropriate technique, depending on the problem he has to solve.
- Interpret the basic mode of operation of specific analytical techniques

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
Production of new research ideas
Exercise criticism and self-criticism
Promoting free, creative and inductive thinking

All of the above

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3. COURSE SYLLABUS

1) Interaction of radiation with matter, spectral line broadening
2) X-Ray Analysis and modern applications
3) Analytical applications of synchrotron radiation
4) Gamma ray spectrometry,
5) Activation analysis,
6) Mössbauer spectroscopy,
7) Microbeam and surface analysis
8) Environmental radioactivity, the table of isotopes, The radon problem,
9) Membranes in analytical chemistry, Speciation analysis,
10-12) Special applications of selected analytical methods
13) Presentations

4. TEACHING and LEARNING METHODS – ASSESSMENT

LECTURE METHOD *Face to face, distance learning, etc.*	Face to face
USE OF INFORMATION AND COMMUNICATION TECHNOLOGY *Use of ICT in Teaching, in Laboratory Exercises, in Communication with students*	Viewing slides using a PC
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	39
Tutorials	
Lab assignments	
Projects	71
Autonomous study	140
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.*	*Assessment Language: English, Assessment Method: Public Presentation and Multiple Choice Test*

5. DIGITIZATION (use of tools & software)

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6. RECOMMENDED INTERNATIONAL LITERATURE

Books:

- Analytical Chemistry by Robert Kellner (Editor), Matthias Otto (Editor), H. Michael Widmer (Editor), Jean-Michel Mermet (Editor) Wiley-VCH
- Measurement Statistic and Computation (John Wiley and Sons)
- Handbook of Practical X-Ray Fluorescence Analysis (Springer)
- Handbook of X-Ray Spectrometry (Marcel Dekker,Inc.)
- Radiation Protection of the Public and the Environment, International Atomic Energy Agency, Vienna 2018

Journals:

- Chemical Review (American Chemical Society)
- Analytical Chemistry (American Chemical Society) Special issues
- Analyst (The Royal Society of Chemistry) Tutorial reviews
- X-Ray Spectrometry (Wiley)

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	Technical University of Crete		
DEPARTMENT	Mineral Resources Engineering		
COURSE LEVEL	Graduate		
COURSE ID		**SEMESTER**	Spring
COURSE TITLE	Modern Technologies for the Near-Zero Waste Processing of Low-Grade Primary Ores and Secondary 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	
Laboratories		
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*	Core elective
PREREQUISITES:	Knowledge of Inorganic Chemistry, Mineralogy, Ore processing, Extractive metallurgy, Waste management, Social aspects
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=76

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:

- ✓ Carry out literature review, assess the State of the Art (SoA) in this field and identify innovative technologies
- ✓ Perform basic analyses for each ore / waste type and decide which are the most appropriate treatment technologies
- ✓ Design relevant flowsheets for treatment technologies and carry out mass balance calculations
- ✓ Define the most appropriate ranges of the operating parameters
- ✓ Carry out basic tecno-economic analysis
- ✓ Assess the potential toxicity of the wastes (solids and liquids) and select appropriate waste

management technologies
- ✓ Identify options for the valorization of wastes
- ✓ Do project work, also using PBL, as member of a team
- ✓ Respect the natural environment and contribute towards reaching the respective sustainable development goals (SDGs)

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

Search, analysis and synthesis of data and information
Assessment of the State of the Art (SoA)
Technology assessment (economic, environmental, social)
Assessment of the progress beyond the SoA
Decision making
Teamwork
Working in an interdisciplinary environment
Production of new research ideas
Identify relevant SGDs and Technology Readiness Levels (TRLs)

3. COURSE SYLLABUS

Content

Lecture 1: Evolution of metal production and waste recycling towards a zero-waste approach
Lecture 2: Considerations on ore grades and available low-grade materials - technical aspects
Lectures 3-4: Mineral processing (fundamentals, including case studies)
Lectures 5-7: Metal extraction (SoA, innovation in pyrometallurgical processes, atmospheric and heap leaching, bioleaching, other extraction processes)
Lectures 8: Metal recovery (fundamentals, innovations)
Lecture 9-10: Residue valorization (as construction materials, cements and binders (supplementary cementitious materials, alkali-activated materials))
Lecture 11: Economic sustainability, environmental and safety impact
Lectures 12-13: Social aspects in mining / metallurgical projects

4. TEACHING and LEARNING METHODS – ASSESSMENT

LECTURE METHOD *Face to face, distance learning, etc.*	Face to face, distant learning and PBL: the presence of students in all lectures is obligatory
USE OF INFORMATION AND COMMUNICATION TECHNOLOGY *Use of ICT in Teaching, in Laboratory Exercises, in Communication with students*	Microsoft Excel and Microsoft Powerpoint will be used during classes and project implementation.

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	26
	Tutorials	
	Lab assignments	
	Projects	26
	Autonomous study	98
	Course Total (25 hours' workload/ECTS credit)	***150***
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.*	2 Projects per student (involving teamwork) through PBL. 20' presentation with a ppt file, Q&A: 60% A research article in a relevant topic will be prepared by each student. A ~3 page summary and ppt presentation will be prepared, involving critical analysis of the topic: 40%	

5. DIGITIZATION (use of tools & software)

Students are required to do calculations in Microsoft Excel spreadsheets (mass balance, economic and energy indicators etc) using the relevant tools and also prepare ppt presentations.

6. RECOMMENDED INTERNATIONAL LITERATURE

Ore / Waste Treatment

1. Komnitsas, K., Petrakis, E., O. Pantelaki, A. Kritikaki (2018). Column leaching of Greek low-grade limonitic laterites, Minerals, *Minerals*, 8(9):377; https://doi.org/10.3390/min8090377
2. Mystrioti, C., Papassiopi, N., Xenidis, A., Komnitsas, K. (2018). Counter-current leaching of low-grade laterites with the use of hydrochloric acid and proposed purification options of pregnant solution, *Minerals*, 8:599; https://doi.org/10.3390/min8120599
3. Komnitsas, K., Petrakis, E., Bartzas, G., Karmali, V. (2019). Column leaching of low-grade saprolitic laterites and valorization of leaching residues, *Science of the Total Environment*, 665:347-357 https://doi.org/10.1016/j.scitotenv.2019.01.381
4. Spooren, J., Breemersch, K., Dams, Y., Mäkinen, J., Lopez, M., González-Moya, M., Tripiana, M., Pontikes, Y., Kurylak, W., Pietek, G., Komnitsas, K., Binnemans, K., Varia, J., Horckmans, L., Yurramendi, L., Snellings, R., Peys, A., Onisei, S., Björkmalm, J., Willquist, K., Kinnunen, P. (2020). Near-zero-waste processing of low-grade, complex primary and secondary ores: challenges and opportunities, *Resources, Conservation and Recycling*, 160:104919, https://doi.org/10.1016/j.resconrec.2020.104919
5. Komnitsas, K., Bartzas, G., Petrakis, E. (2023). A novel and greener sequential column leaching approach for the treatment of two different Greek laterites, *Science of the Total Environment*,

854, 158748, http://dx.doi.org/10.1016/j.scitotenv.2022.158748

Waste Valorization

6. Komnitsas, K., D. Zaharaki, V. Perdikatsis (2007). Geopolymerisation of low calcium ferronickel slags, *Journal of Materials Science*, 42(9), 3073-3082, http://dx.doi.org/ 10.1007/s10853-006-0529-2
7. Komnitsas, K., Zaharaki, D., V. Perdikatsis, (2009). Effect of synthesis parameters on the compressive strength of low-calcium ferronickel slag inorganic polymers, *Journal of Hazardous Materials*, 161:760-768, http://dx.doi.org/10.1016/j.jhazmat.2008.04.055
8. Zaharaki, D., K. Komnitsas, V. Perdikatsis (2010). Use of analytical techniques for identification of inorganic polymer gel composition, *Journal of Materials Science*, 45(10):2715-2724, http://dx.doi.org/10.1007/s10853-010-4257-2
9. Komnitsas, K. (2011). Potential of geopolymer technology towards green buildings and sustainable cities, *Procedia Engineering*, 21: 1023-1032, http://dx.doi.org/10.1016/j.proeng.2011.11.2108
10. Komnitsas, K., Zaharaki, D., Vlachou, A., Bartzas, G., Galetakis, M. (2015). Effect of synthesis parameters on the quality of construction and demolition wastes (CDW) geopolymers, *Advanced Powder Technology* 26(2):368-76, http://dx.doi.org/10.1016/j.apt.2014.11.012
11. Komnitsas, K., Bartzas, G., Karmali, V., Petrakis, E., Kurylak, W., Pietek, G., Kanasiewicz, J. (2019). Assessment of alkali activation potential of a Polish ferronickel slag, *Sustainability*, 11:1863, https://doi.org/10.3390/su11071863
12. Petrakis, E., Karmali, V., Bartzas, G., Komnitsas, K. (2019). Grinding kinetics of slag and effect of final particle size on the compressive strength of alkali activated materials, *Minerals*, 9:714, doi:10.3390/min9110714
13. Komnitsas K., Bartzas, G., Karmali, V., Petrakis, E. (2021). Factors Affecting Alkali Activation of Laterite Acid Leaching Residues, *Environments*, 8, 4, https://doi.org/10.3390/environments8010004
14. Karmali, V., Petrakis, E., Bartzas, G., Komnitsas, K. (2022). Valorization Potential of Polish Laterite Leaching Residues through Alkali Activation. *Minerals*, 12(11), 1466, https://doi.org/10.3390/min12111466

Environmental topics

15. Xenidis, A., N. Papassiopi, **K. Komnitsas** (2003). Carbonate rich mine tailings in Lavrion: Risk assessment and proposed rehabilitation schemes, *Advances in Environmental Research*, 7(2), 207-222, http://dx.doi.org/10.1016/S1093-0191(02)00017-5
16. Triantafyllidis S., Skarpelis N., **Komnitsas K.** (2007). Environmental characterisation of the Kirki (NE Greece) flotation tailings, *Environmental Forensics*, 8(4), 351-359, http://dx.doi.org/10.1080/15275920701729688
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22. Bartzas, G., **Komnitsas, K.** (2017). Life cycle analysis of pistachio production in Greece, *Science of the Total Environment*, 595:13-24, http://dx.doi.org/10.1016/j.scitotenv.2017.03.251

23. Ekman Nilsson, A., Macias Aragones, M., Royo, F., Dunon, V., Oorts, K., Angel, H., **Komnitsas, K.**, Willquist, K. (2017). A Review of the Carbon footprint of Cu and Zn production from primary and secondary sources, *Minerals*, 7:168, https://doi.org/10.3390/min7090168

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25. **Komnitsas, K.**, Yurramendi, L., Bartzas, G., Karmali, V., Petrakis, E. (2020). Factors affecting co-valorization of fayalitic and ferronickel slags for the production of alkali activated materials, *Science of the Total Environment*, 721:137753, https://doi.org/10.1016/j.scitotenv.2020.137753

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26. **Komnitsas, K.** (2020). Social License to Operate in Mining. Present views and future trends, *Resources* 2020, 9:79, doi:10.3390/resources9060079

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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	
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=77

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
- The change in mindset and way of thinking

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

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

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 *Face to face, distance learning, etc.*	Virtual
USE OF INFORMATION AND COMMUNICATION TECHNOLOGY *Use of ICT in Teaching, in Laboratory Exercises, in Communication with students*	Powerpoint presentations, videos and e-class support

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	39
Tutorials	
Lab assignments	
Projects	100
Autonomous study	120
Course Total (25 hours workload/ECTS credit)	***259***

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.*	Project (100%)

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.
- Stefanakis, A.I. and Nikolaou, I., 2021. Circular Economy and Sustainability - Management and Policy, Volumes I & II. Elsevier Publishing, Amsterdam, The Netherlands, September.
- A. Wijkman and K. Skanberg, "The Circular Economy and Benefits for Society," Sections 2 and 4, 2015
- Ellen MacArthur Foundation, "Completing the picture – How the Circular Economy tackles climate change", September 2019.
- 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=78

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.

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

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*
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 *Face to face, distance learning, etc.*	Hybrid
USE OF INFORMATION AND COMMUNICATION TECHNOLOGY *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 *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	40
Tutorials	
Lab assignments	
Projects	50
Autonomous study	135
Course Total (25 hours' workload/ECTS credit)	***9 ECTS overall***

ASSESSMENT METHODS *Description of the evaluation process* *Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test,*	The language of assessment is English. Assessment constitutes of two parts: 1) Project

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.*	2) Final examination The two aspects of assessment count equally (50% + 50%) towards the final grade that the student will be awarded in the module. 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. 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=79

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 *Face to face, distance learning, etc.*	Direct (face to face) and distance learning
USE OF INFORMATION AND COMMUNICATION TECHNOLOGY *Use of ICT in Teaching, in Laboratory Exercises, in Communication with students*	• Power point presentations • E-class support
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	39
Tutorials	
Lab assignments	
Projects	100
Autonomous study	86
Course Total (25 hours' workload/ECTS credit)	***225***

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.*	Assessment Language: English Assessment Method: Individual project including public presentation and oral examination. 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.

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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. 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). 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=80		

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 1st Assignment: delve into an IPCC Headline Statement (group assignment)
3rd Week:	Key concepts for Assessing Climate Change Impact. Presentation of the 1st assignment
4th Week:	Climate Change Impacts: A Global and European Perspective The IPCC interactive Atlas. 2nd Assignment: IPCC WG1 AR6 Interactive ATLAS (individual assignment)
5th Week:	Climate Change Impacts: A local scale Perspective Presentation of the 2nd assignment

6th Week:	CCIA Projects Prospectus, roundtable discussion 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 *Face to face, distance learning, etc.*	Hybrid (Face to face and Distance learning)
USE OF INFORMATION AND COMMUNICATION TECHNOLOGY *Use of ICT in Teaching, in Laboratory Exercises, in Communication with students*	• Moodle learning platform • Zoom communication platform
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	30
Practical classes and workshops	9
Autonomous study	58
Assignments/tasks	62
Projects	66
Course Total (25 hours' workload/ECTS credit)	***225***

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.*	Assignments (40%) Final project report (40%) 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).

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COURSE OUTLINE

1. COURSE INFORMATION

SCHOOL	Chemical and Environmental Engineering		
DEPARTMENT			
COURSE LEVEL	Postgraduate		
COURSE ID		**SEMESTER**	Spring
COURSE TITLE	Advanced Studies on Energy Efficiency and Environmental Quality in the Built Environment		

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*	Specialization
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=85

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:

- Analyse the key technologies that contribute to improving the energy efficiency of buildings, districts, and urban built environments.
- Calculate the energy demand and energy consumption of buildings and communities.
- Comprehend the role of built environment in sustainable development goals.
- Identify the main challenges in buildings and living spaces related projects.
- Practise in real case studies examples.
- Use available tools and technologies for the reduction of the energy demand in the built environment.

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

- Research, analysis and synthesis of data and information, using the necessary technologies
- Adapting to new situations
- Decision-making
- Autonomous work
- Teamwork
- Production of new research ideas
- Project design and Management
- Respect for the natural environment
- Promoting free, creative, and inductive thinking
- Written communication
- Initiative
- Time Management
- Problem Solving

3. COURSE SYLLABUS

Content: The course aims to analyze, design, and evaluate the key technologies that contribute to improving the energy efficiency of buildings, districts and urban built environments. In addition, the course aims to analyze the environmental quality parameters indoors and in outdoor areas. Thermal comfort, visual comfort and indoor air quality is presented.

Course Material per Week (13 weeks):

Week 1: Energy needs in buildings, communities, and cities. Modern challenges for the built environment
Week 2: Indoor Environmental Quality in Buildings - Part 1: Thermal Comfort
Week 3: Indoor Environmental Quality in Buildings - Part 2: Air Quality and Ventilation / Air Conditioning Systems
Week 4: Indoor Environmental Quality in Buildings - Part 3: Visual comfort and lighting
Week 5: Smart Buildings and Integrated Energy Design - Definitions and Examples
Week 6: Buildings Certification LEED and BREEAM Standards
Week 7: Zero Energy Communities and Intelligent Energy Systems
Week 8: Energy planning in the urban environment and urban heat island phenomenon
Week 9: Presentations of work progress
Week 10: Smart cities and energy infrastructure - Part 1: Definitions
Week 11: Smart cities and energy infrastructure - Part 2: Examples
Week 12: Case Study Analysis
Week 13: Presentations

4. TEACHING and LEARNING METHODS – ASSESSMENT

LECTURE METHOD *Face to face, distance learning, etc.*	Face to face; hybrid (on-site and online)
USE OF INFORMATION AND COMMUNICATION TECHNOLOGY *Use of ICT in Teaching, in Laboratory Exercises, in Communication with students*	

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	30.0
	Tutorials	
	Lab assignments	45.0
	Projects	30.0
	Autonomous study	100.0
	Literature review	20.0
	Course Total (25 hours' workload/ECTS credit)	***225.0***
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.*	Project (100%)	

5. DIGITIZATION (use of tools & software)

6. RECOMMENDED INTERNATIONAL LITERATURE

1. Kampelis, N., Kolokotsa, D. Smart Zero-energy buildings and communities for smart grids (2022) Smart Zero-Energy Buildings and Communitiesfor Smart Grids, pp. 1-289. ISBN: 978-1-119-90219-5Wiley-ISTE.
2. Kolokotsa, D., Kampelis, N., Mavrigiannaki, A., Gentilozzi, M., Paredes, F., Montagnino, F.M., Venezia, L. Integration of energy storage in smartcommunities and smart grids (2022) Smart Zero-Energy Buildings and Communities for Smart Grids, pp. 221-262.
3. Kolokotsa, D., Pignatta, G., Ulpiani, G. Nearly Zero-Energy and Positive-Energy Buildings: Status and Trends (2022) Technologies for IntegratedEnergy Systems and Networks, pp. 239-273.

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COURSE OUTLINE

1. COURSE INFORMATION

SCHOOL	School of Production Engineering and Management		
DEPARTMENT	-		
COURSE LEVEL	Postgraduate		
COURSE ID		**SEMESTER**	Winter / Spring
COURSE TITLE	Inventories and Supply Chains		

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	1	
Tutorial Exercises	1	
Total	5	5
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:	-
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=86

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 students will be able to:

- Describe and Formulate Supply Chain Management Problems, such as product transportation, vehicle routing problem, facility location, inventory management, scheduling of operations
- Solve supply chain management problems
- Apply heuristics, metaheuristics, evolutionary and nature-inspired algorithms to solve supply chain management problems
- Program the algorithms for solving Supply Chain Management problems in Matlab, C, C++ and Python programming languages
- Analyze real-life situations of supply chain management problems
- Practice solving complex supply chain management problems
- Use software packages to solve supply chain management problems

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
- Production of new research ideas
- Project design and management
- Innovative thinking
- Working in an international environment
- Working in an interdisciplinary environment
- Computer use
- Problem solving
- Managing numerical data
- 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

3. COURSE SYLLABUS

The role of the supply chain management. Demand and supply planning in a supply chain. Applications and mathematical formulation. The traveling salesman problem. The bin packing problem. Transportation and distribution of products in the supply chain. Distribution network design. Distribution channels. Route planning. Problems of fleet selection and vehicle size. Vehicle routing problem. Variants of the vehicle routing problem. Scheduling problems. Facility location problems. Inventory management. Inventory routing problems in logistics (Single period inventory routing problem, multi-period inventory routing problem). Integrated supply chain management systems. Maritime logistics. Green supply chain. Electric and unmanned aerial vehicles in the supply chain.

Laboratory courses: For a better understanding of the course, students are required to perform laboratory exercises in C, C++, Python or Matlab, solving real supply chain management problems. Each group of students implements a different problem with different programming tools and different solution algorithms.

4. TEACHING and LEARNING METHODS – ASSESSMENT

LECTURE METHOD *Face to face, distance learning, etc.*	Face to face/Distance Learning
USE OF INFORMATION AND COMMUNICATION TECHNOLOGY *Use of ICT in Teaching, in Laboratory Exercises, in Communication with students*	**Use of ICT in Teaching:** Notes and presentations of lectures of the course in moodle, courses by videoconference. **Use of ICT in Laboratory Exercises:** Notes and presentations of laboratory lectures of the course in moodle and courses by videoconference. Learning different programming languages and their use for creating programs in the subject of the course.

	Use of ICT in Communication with students: Solving questions via videoconference and email
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: 39 Tutorials: 13 Lab assignments: 13 Projects: 20 Autonomous study: 40 ***Course Total (25 hours' workload/ECTS credit)***: ***125***
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.*	Written Final Examination (Multiple Choice Questions or/and Problem Solving Questions) 50% Team Project (Problem Solving, Essay / Report, Public Presentation) 30% Individual Project (Problem Solving, Essay / Report, Public Presentation) 20%

5. DIGITIZATION (use of tools & software)

Moodle, eclass, matlab, python, c, c++

6. RECOMMENDED INTERNATIONAL LITERATURE

1. Waters D., (2003) Logistics: An Introduction to Supply Chain Management, Palgrave Macmillan.
2. Lambert D., Stock J., Ellram L., (1998) Fundamentals of Logistics Management, McGraw-Hill.
3. Ravindran, Ravi; Warsing, Donald Jr. (2017). Supply chain engineering: models and applications. CRC Press.
4. Robert B. Handfield; Ernest L. Nichols (1999). Introduction to Supply Chain Management. New York: Prentice-Hall.
5. Roberta S. Russell, Bernard W. Taylor (2021). Operations and Supply Chain Management, 10th edition, John Wiley & Sons.
6. F. Robert Jacobs and Richard Chase (2018). Operations and Supply Chain Management, 15th edition, McGraw-Hill
7. Sunil Chopra, Peter Meindl (2014) Supply Chain Management, Strategy, Planning and Operation, 6th edition, Pearson.
8. Alan Harrison and Remko Van Hoek (2007) Logistics Management and Strategy. Competing through the Supply Chain 4th Edition, Prentice Hall

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