COURSE OUTLINE

1. COURSE INFORMATION

SCHOOL	Chemical and Environmental Engineering		
DEPARTMENT	Chemical and Environmental Engineering		
COURSE LEVEL	Graduate		
COURSE ID	**AB308**	**SEMESTER**	Winter
COURSE TITLE	Applied Mathematics for Environmental Engineers		

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	4	
Laboratories		
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*	Scientific area
PREREQUISITES:	Calculus, Basic Probability & Statistics, Basic O.D.E.s
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=82

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*

This is an introductory graduate course on the topics: ordinary and partial differential equations, Laplace and Fourier transforms, applications of o.d.es, estimation theory, hypothesis testing, simple and multiple linear regression, chi-square goodness of fit and independence, applications of Statistics, time series (decomposition and smoothing, applications of time series to forecasting knowledge necessary to an Environmental engineer.

Using this knowledge he/she can solve, by constructing mathematical models, real life environmental problems. During the lectures, the analytical theory (in each one of the subjects) is given and mathematical models/scenarios for environmental problems are being constructed.

SPSS, MINITAB, MATLAB software are also being introduced and implemented.

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

The goals are:

- the study of different areas of Mathematics (O.D.E, Statistics, Time series) for (real life) problem solving
- the understanding of the difference between approximation/estimation and analytical methods,
- the familiarization of the students with specialized software programs and the use of these programs in solving real problems (scenarios).

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

Content

1st week: Ordinary differential equations. Initial value problems. Separable o.d.es, linear of 1st order

2nd week: Applications of 1st order o.d.es (population, mixing, decay, dating, chemical, environmental e.t.c models)

3rd week: Second and higher order o.d.es. Applications of 2nd order o.d.es to electricity/ circuits, mechanics e.t.c.

4th week: Laplace transforms. Use of Laplace transforms to the solution of o.d.es

5th week: Applications of Laplace transforms. Fourier transforms

6th week: Probability Review. Applications of Probability

7th week: Statistics Review. Estimation theory. Confidence intervals. Applications

8th week: Hypothesis testing. Applications

9th week: Simple and multiple linear regression. Applications

10th week: Chi-square goodness of fit test. Chi-square test of independence. Applications

11th week: Time series. Characteristics of a time series. Examples

12th week: Decomposition of a time series. Forecasting with decomposition.

13th week: Smoothing of a time series. Forecasting with smoothing.

4. TEACHING and LEARNING METHODS – ASSESSMENT

LECTURE METHOD *Face to face, distance learning, etc.*	Class lectures and/or distance learning
USE OF INFORMATION AND COMMUNICATION TECHNOLOGY *Use of ICT in Teaching, in Laboratory Exercises, in Communication with students*	• Power point presentations • Use of Specialized software • E-class support/ moodle course
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	52
Tutorials	6
Lab assignments	6
Projects	8
Autonomous study	55
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.*	• Homework problems (30%): (5 weekly homework problems- use of software needed) • Final exam in the form of Project (70%): take-home real-life scenarios/data

5. DIGITIZATION (use of tools & software)

- SPSS,
- MINITAB,
- MATLAB
- software is being introduced and implemented

6. RECOMMENDED INTERNATIONAL LITERATURE

Ordinary differential Equations

- Elementary Differential Equations and Boundary Value Problems, William E. Boyce, Richard C. DiPrima, Douglas B. Meade, 11th Edition
- Differential equations Schaum's Outline, Richard Bronson, Gabriel Costa, 5th.

Probability and Statistics

- Applied Statistics and Probability for Engineers, Douglas C. Montgomery, George C. Runger, 7th Edition, EMEA
- First Course in Probability, Sheldon Ross, A, 10th edition, 2019, pub. Pearson.
- Introduction to Probability and Statistics Schaum's Outline, Lipschutz Seymour, John Schiller
- Theory and problems of Statistics and Econometrics, Schaum's Outline, Dominic Salvatore,

Derick Reagle, 2nd.

Time series

- Forecasting: Principles and Practice, Rob J Hyndman and George Athanasopoulos, 3rd ed.
- The analysis of time series. An introduction, Chatfield, C., Chapman & Hall.
- Practical Time Series Forecasting: A Hands-On Guide, by Galit Shmueli, 3rd ed.

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	Graduate		
COURSE ID	**BEKA 300**	**SEMESTER**	Winter
COURSE TITLE	Climate Change and GHG Emissions		

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	9
Laboratories		
Tutorial Exercises		
Total	3	
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
PREREQUISITES:	Basic knowledge in calculus
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=84

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*

Upon successful completion of this course the students will acquire new knowledge and specific skills on the following subjects:

- Will have knowledge of the basic characteristics of the Earth's atmosphere (structure, density, temperature lapse rate, pressure and energy balance).
- Will have knowledge of the composition of the atmosphere
- Will have knowledge of the impact of the greenhouse effect to the temperature balance of the planet.
- Will have knowledge of the basic characteristics of particulate matter (density, chemical properties, size and sources).
- Will be capable to use the basic principles of the Eulerian and Lagrangian air quality models to calculate the concentration of pollutants in air.
- Will be able to apply Gaussian models for the calculation of air pollutants concentration.
- Will have knowledge to use simple models for calculating the carbon foot print from houses and

industrial facilities
- Will be able to apply simple climate models for the calculation of GHG levels and emissions
- Will have knowledge of the air quality and climate legislation concerning gaseous and particulate matter pollutants.

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

- Adaptation ability
- Decision making
- Respect of the Environment
- Advance free, creative and causative thinking

3. COURSE SYLLABUS

The course aims to the analysis and formulation of design criteria for the application of measures for the reduction of greenhouse gas (GHG) emissions in the atmosphere. It is also formulates the calculation of GHG emissions from anthropogenic and natural sources. Air pollutants and aerosols are also studied together with mathematical dispersion models, as well as, climatic models. In addition, the energy balance in Earth is studied using mathematical models. Finally, the course includes a number of laboratory exercises.

Syllabus

1st week: Atmospheric structure and composition
2nd week: Air pollutants
3rd week: Radiation in the atmosphere. Greenhouse effect
4th week: Energy balance and climate
5th week: Emissions of gaseous components and aerosols. Air pollution dispersion
6th week: Atmospheric chemistry and climate
7th week: Atmospheric aerosols and effects on visibility and climate
8th week: Climate Characteristics
9th week: Single cell models. Climate models
10th week: GHG pollutants
11th week: Formulation of an emission inventory
12th week: Project for the calculation of the Carbon dioxide in the atmosphere
13th week: Project for the calculation of the Carbon footprint

4. TEACHING and LEARNING METHODS – ASSESSMENT

LECTURE METHOD *Face to face, distance learning, etc.*	Face to face in conjunction with 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 and Laboratory Exercises

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	10
	Projects	41
	Autonomous study	135
	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.*	1. Lab reports (10%) 2. Written assignments (20%) 3. Project (35%) 4. Final exam (35%)	

5. DIGITIZATION (use of tools & software)

- European GHGCalculator
- BoxModel_CO2
- Sgec_tool

6. RECOMMENDED INTERNATIONAL LITERATURE

1. Seinfeld J. H. and Pandis, S. N. Atmospheric Chemistry and Physics John Wiley & Sons (2006).
2. IPCC Fifth Assessment Report(http://www.ipcc.ch/report/ar5/wg1).
3. Mihalis Lazaridis. First Principles of Meteorology and Air Pollution. Springer (2010).

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 & Environmental Engineering		
DEPARTMENT			
COURSE LEVEL	Postgraduate		
COURSE ID		**SEMESTER**	Winter
COURSE TITLE	Design of Sustainable Energy & Mobility Systems		

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	9
Laboratories		
Tutorial Exercises		
Total	3	
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*	Scientific Area
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=83

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:

- Implement an environmental impact analysis
- use of alternative fuels in transport (biofuels, electricity, etc.)
- manage Renewable Energy Sources and Energy Saving systems (regional-local energy planning, sustainable management of natural resources, Life Cycle Analysis),
- design of green energy applications for buildings, cities and ports

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

Respect for diversity and multiculturalism

Adaptation to new situations *Decision making* *Autonomous work* *Teamwork* *Working in an international environment* *Working in an interdisciplinary environment* *Production of new research ideas*	*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
Decision making
Adaptation to new situations
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

0. Introduction

1. Basic design principles.

2. Demonstration of using the ReSEL-PLAN toolbox.

3. Use of Life Cycle Analysis to study environmental impacts.

4. zero Energy Systems

5. (two weeks). Special applications of renewable energy sources. Electrical systems. Wind -

photovoltaic - hybrid. Desalination, autonomous energy systems. Solar air conditioning. Integration

into the built environment.

6. Biofuels. Energy, environmental and economic assessment.

7. Multi-criteria analysis for the optimal choice of sustainable energy and transport systems.

8 (two weeks).Sustainable large-scale zero emission system design (islands, cities, ports).

9. Economics, system dimensioning and examples. Discussion.

10. Final presentation of all students' projects

4. TEACHING and LEARNING METHODS – ASSESSMENT

LECTURE METHOD *Face to face, distance learning, etc.*	Hybrid (both physical and virtual)
USE OF INFORMATION AND COMMUNICATION TECHNOLOGY	• **Zoom** • Powerpoint presentations, videos and e-class support

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	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 development of a sustainable energy & transport system **Criteria:** Scientific & technical readiness, quality of the deliverable, initiative, quality of presentation

5. DIGITIZATION (use of tools & software)

- ReSEL Virtual library containing 10+ engineering tools
- ReSEL-Plan Tool to develop and implement sustainable energy communities

6. RECOMMENDED INTERNATIONAL LITERATURE

Publications using the ReSEL library:
http://www.resel.tuc.gr/index.php?option=com_content&view=article&id=8&Itemid=26&lang=en

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	Raw Materials Exploitation Methods with Low Environmental Footprint		

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	1	
Laboratories	1	
Tutorial Exercises	1	
Total	3	
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*	*Skills Development in safe mine design*
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=72

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:

- Demonstrate knowledge and understanding in basic principles of safe mining design.
- Apply their knowledge and understanding the design of an operation from the selection of the appropriate equipment to the rehabilitation of the mine after the end of operations.
- Gather and interpret the necessary information needed to define the optimum method used in the mineral extraction.
- Communicate information, ideas, problems and solutions to both specialist and non-specialist audiences.
- Develop those learning skills that are necessary for them to continue to undertake further study with a high degree of autonomy.

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

- *Decision making*
- *Autonomous work*
- *Project design and management*
- *Respect for the natural environment*
- *Production of new research ideas*
- *Search, analysis and synthesis of data and information, using the necessary technologies*

3. COURSE SYLLABUS

Week 1: Lessons 1-2
Week 2: Lesson 2, Tutorial exercises, Project 1.
Week 3: Laboratory 1.
Week 4: Lesson 3, Tutorial exercises.
Week 5: Lesson4, Tutorial exercises, Project 2.
Week 6: Laboratory 2.
Week 7: Lesson 5, Tutorial exercises, Project 3.
Week 8: Lesson 6, Tutorial exercises.
Week 9: Laboratory 3.
Week 10: Lesson 7, Tutorial exercises.
Week 11: Laboratory 4.
Week 12: Lesson 8, Tutorial exercises.
Week 13: Lesson 9, Tutorial exercises, Project 5.
Presentation of autonomous Project.

In more details the lessons include:
Lesson 1: Introduction into mining (1 slide-1 hours)

- Mining Terminology.
- Advancements in mining technology.
- Stages in the life of the mine.

Lesson 1-2: Operational Analysis (1 slide, 5 hours)

- Fundamentals unit operations and cycles.
- Drilling and other penetration methods.
- Blasting-rock fragmentation.
- Loading and excavation.
- Haulage and hoisting.
- Cycles and systems.
- Mine surveying.
- Electrification.
- Tutorial exercises.
- Project 1: operational analysis (Select appropriate machinery based on the production needs).

Laboratory1: Introduction in Surpac or AutoCAD for design in surface mining (3 hours)
Lesson3-4: Slope stability (1 slide, 3 hours)

- Use of Stereographic projections.
- Rotational failure.
- Plane failure.
- Wedge failure.
- Toppling failure.
- Tutorial exercises.
- Project 3: Define the optimum design of surface excavation based on cost and safety of the designed slopes.

Laboratory2: Surpac or AutoCAD for design in surface mining (3 hours)
Lesson 5-6: Underground excavation methods (1 slide, 6 hours)

- Development openings.
- Shaft-hoisting system.
- Open stope methods (unsupported methods)
- Supported Methods.
- Caving Methods.
- MRMR rating system.
- Abandoned mines use.
- Tutorial exercises.

Laboratory3: Surpac or AutoCAD for design development openings (3 hours)
Lesson 7: Underground excavation methods II (1 slide, 3 hours)
Laboratory4: Introduction in Ventsim software (3 hours).
Lesson 8-9: Rock mechanics (2 slides, 6 hours).

- Stress-strain tensors.
- Methods of stress analysis.
- Rock strength.
- Excavation design in massive elastic, stratified and jointed rock, respectively.
- Rockmass classification systems.
- Stresses distribution around unsupported circular excavation.
- Block theory.
- Wedge stability.
- Chimney caving.
- Tutorial exercises.
- Project 5: Estimating dangerous wedges in underground excavation..

4. TEACHING and LEARNING METHODS – ASSESSMENT

LECTURE METHOD *Face to face, distance learning, etc.*	A scheme combining face to face and distance learning.
USE OF INFORMATION AND COMMUNICATION TECHNOLOGY *Use of ICT in Teaching, in Laboratory Exercises, in Communication with students*	Email, e-class, video material

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	13
Tutorials	13
Lab assignments	13
Projects	53
Autonomous study	58
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.*	**Assessment Language:** English **Assessment Methods:** • Project assignment: 20%. Answer questions in eclass platform. Answers evaluated automatically. • Laboratory assignment: 20%. For evaluation of student the participation is required. Report delivery which is graded on the basis of quality and results. • Autonomous study: 60%. Report delivery which is graded based on quality and results. Presentation

5. DIGITIZATION (use of tools & software)

- E-class
- GEOVIA Surpac: geology and mine planning software (or AutoCAD instead)
- Ventsim: mine ventilation software.
- Programing in excel and MATLAB.

6. RECOMMENDED INTERNATIONAL LITERATURE

- Brady, B.H.G. & Brown, E.T., 1985. Rock Mechanics for Underground Mining. George Allen & Unwin, London, UK.
- Goodman, R.E. and Shi, G.H,m 1985. Block theory and application to rock engineering. PRENTICE-HALL INC., Englewood Cliffs, New Jersey.
- Hartman, H.L & Mutmansky, J.M., 2002. Introductory Mining Engineering. Wiley, Hoboken, New Jersey, 2nd edition.
- Hustrulid, W. & Kuchta, M., 2006. Open Pit Mine & Design. Taylor & Francis/Balkema, London, UK, 2nd edition, Volume 1 Fundamentals.
- McPherson, M.J., 1993. Subsurface Ventilation Engineering. SRKs Mine Ventilation.
- Wyllie, D.C. & Mah, C.W., 2004. Rock Slope Engineering: Civil and Mining. Taylor & Francis, London, UK, 4th edition (based on 3rd edition of Hoek & Bray).

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	Chemical and Environmental Engineering		
DEPARTMENT			
COURSE LEVEL	Postgraduate		
COURSE ID		**SEMESTER**	Winter
COURSE TITLE	Solid and Toxic Waste Management		

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		
Tutorial Exercises	1	
Total	3	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, Scientific area
PREREQUISITES:	Basic biology, chemistry, and geochemistry knowledge
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=81

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:

- Understand basic principles on solid and hazardous waste management
- Apply the best approach based on waste properties and characteristics
- Design collection and transportation systems
- Estimate the landfill size or treatment facilities for specific case studies
- Determination of physicochemical characteristics of degradation products (landfill leachate, biogas)
- Perform risk assessment

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
- Autonomous work
- Teamwork
- Working in an international environment

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

3. COURSE SYLLABUS

1st Week: Introduction to Integrated Solid Waste Management

2nd Week: Reduce, Reuse, Recycle, Recovery… The Rs of Solid Waste Management

3rd Week: Biological Conversion Technologies (aerobic composting)

4th Week: Biological Conversion Technologies (anaerobic digestion)

5th Week: Thermal Conversion Technologies (incineration)

6th Week: Advanced Thermal Systems (pyrolysis, gasification, air pollution control)

7th Week: Waste disposal

8th Week: Landfill design

9th Week: Hazardous waste: Main characteristics, classification, labeling, toxicology and risk analysis

10th Week: Physico-chemical and thermal treatment of hazardous waste

11th Week: Disposal of hazardous waste

12th Week: Dioxins (PCDDs), Furans (PCDFs) and Polychlorinated Biphenyls (PCBs)

13th Week: Project presentation and discussion

4. TEACHING and LEARNING METHODS – ASSESSMENT

LECTURE METHOD *Face to face, distance learning, etc.*	Distance learning
USE OF INFORMATION AND COMMUNICATION TECHNOLOGY *Use of ICT in Teaching, in Laboratory Exercises, in Communication with students*	Power point presentations; Moodle 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	26
Tutorials	13
Assignment and Project	26
Autonomous study	60
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.*	• Oral exam (50%) • Final project report (25%) • Project presentation and discussion (25%)

5. DIGITIZATION (use of tools & software)

Power point presentation

6. RECOMMENDED INTERNATIONAL LITERATURE

- Tchobanoglous G., Kreith F. (2002) Handbook of Solid Waste Management (2nd Ed.). McGraw-Hill, USA.
- Chandrappa R., Das D.B. (2012) Solid Waste Management: Principles and Practice. Springer, Germany.
- Unnisa S.A, Rav S.B. (2012) Sustainable Solid Waste Management. Taylor & Francis, USA.
- Christensen T.H. (2011) Solid Waste Technology and Management. Wiley, UK.

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