COURSE OUTLINE

1. GENERAL

SCHOOL	ENGINEERING		
DEPARTMENT	ENVIRONMENTAL ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE – 7		
COURSE CODE	**Z5ΥΠ**	**SEMESTER**	**7th (Fall)**
COURSE TITLE	SOLID WASTE TECHNOLOGY AND MANAGEMENT-II		

TEACHING ACTIVITIES *If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.*	**TEACHING HOURS PER WEEK**	**ECTS CREDITS**
Lectures	3	
Laboratory	3	
Please, add lines if necessary. Teaching methods and organization of the course are described in section 4.	6	5

COURSE TYPE *Background, General Knowledge, Scientific Area, Skill Development*	Skill development
PREREQUISITES:	Solid waste technology and management-I, Fluid mechanics
TEACHING & EXAMINATION LANGUAGE:	Greek
COURSE OFFERED TO ERASMUS STUDENTS:	Yes
COURSE URL:	https://eclass.duth.gr/courses/TMC289/ **in GREEK**

2. LEARNING OUTCOMES

Learning Outcomes

Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

1. <u>Knowledge based</u>

- Understanding of the principles of science and technology, which are used for siting, design, construction, operation and aftercare of municipal solid waste landfills.
- Familiarization with the European and Hellenic legislation dealing with sanitary landfilling.
- Understanding of the role of sanitary landfilling in the integrated municipal solid waste management.
- Understanding of the particular units/sections of a sanitary landfill and their coordinated operation.
- Understanding of the basic design calculations, dealing with production and management of biogas and leachate.
- Use of models, such as HELP and the monthly water balance and the advection-dispersion-adsorption equation in sanitary landfill problems.
- Understanding of the concept of bioreactor landfill.

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information, ICT Use
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
Equity and Inclusion
Respect for the natural environment
Sustainability
Demonstration of social, professional and moral responsibility and sensitivity to gender issues
Critical thinking
Promoting free, creative and inductive reasoning

2. **Skills/Competences acquired**

After the successful completion of the course, the students will be in a position to do a preliminary design of a sanitary landfill in a specific area, which includes:

- Ability to site a sanitary landfill.
- Ability to do a basic sizing of a sanitary landfill.
- Ability to design the disposal phases in a sanitary landfill.
- Ability to design a leachate collection network.
- Ability to design a biogas collection network.
- Ability to design restoration and monitoring works after sanitary landfill closure.

3. COURSE CONTENT

LECTURES (taught by Professor E.A. Voudrias)

1. Land disposal of municipal solid waste (MSW) and residual waste – historical retrospection – general description of sanitary landfills (SLs) – European and Hellenic legislation
2. Functional relationships between SL capacity and active base area – examples – bottom lining with clay materials
3. Design and construction of clay liners – examples – geosynthetic materials
4. Composite liners – double liners – examples
5. Calculation of leachate leakage and contaminant breakthrough in clay and composite liners – examples
6. Biogas production in a SL – biogas production phases – calculation of total biogas production – examples
7. Temporal distribution of biogas production – LandGem model – transport of biogas trace components – examples
8. Biogas management – passive systems – active systems – design of a biogas collection system – biogas combustion and production of energy – calculation of condensate production – examples
9. Leachate production – composition and characteristics – water balance in a sanitary landfill – HELP model and Tchobanoglous et al. model – leachate movement – transport of leachate constituents – advection-dispersion-adsorption equation – examples
10. Leachate management – drainage zone design – leachate collection in a sloping liner – Collection pipes analysis – examples
11. Overview of leachate treatment methods – sanitary landfill covers – preliminary and final cover – examples
12. Sanitary landfill geotechnical stability – settling – closure of sanitary landfill – aftercare
13. Bioreactor landfill – leachate recirculation methods – design – examples

LABORATORY EXERCISES (taught by Professor D. Komilis, with laboratory support by I. Papaspyros)

1. Basic sizing of a sanitary landfill
2. Detailed design of a sanitary landfill in a specific area – soil balance and design of disposal phases
3. Design of leachate collection and treatment system
4. Design of biogas collection system – design of restoration and monitoring after sanitary landfill closure

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD *Face to face, Distance learning, etc.*	Face-to-face teaching of course contents, using overhead transparencies and blackboard. Complementary design exercises are accessed through

	the e-class platform. The course, also, includes a laboratory section with required submission of technical reports.
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) *Use of ICT in Teaching, in Laboratory Education, in Communication with students*	Use of e-class for communication with students.
TEACHING ORGANIZATION *The ways and methods of teaching are described in detail.* *Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research & analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc.* *The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards.*	
STUDENT EVALUATION *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, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others* *Please indicate all relevant information about the course assessment and how students are informed*	Essay development questions: 9% Problem Solving: 51% Laboratory reports: 40%

Activity	*Workload/semester*
Lectures	39
Laboratory exercises	39
Bibliographic research and analysis	42
Laboratory reports	30
TOTAL	**150**

5. SUGGESTED BIBLIOGRAPHY

1. Voudrias, E.A. (2015). “Technology of Municipal Solid Waste Sanitary Landfills”, edition of Democritus University of Thrace.
2. Komilis, D. (2020). “Solid waste management and engineering”, ISBN 978-960-418-622-8, Tziola Publications, Thessaloniki, Greece.

ANNEX OF THE COURSE OUTLINE

Alternative ways of examining a course in emergency situations

Teacher (full name):	Evangelos Voudrias (lectures), Dimitrios Komilis (laboratory) and Ioannis Papaspyros (laboratory support)
Contact details:	voudrias@env.duth.gr dkomilis@env.duth.gr ipapaspi@env.duth.gr
Supervisors: (1)	YES
Evaluation methods: (2)	Written examination with distance learning methods, provided that the integrity and reliability of the examination are ensured. Written laboratory reports, after each lab exercise is executed.
Implementation Instructions: (3)	Written open-book examination with distance learning methods, using e-class to administer the questions to be answered and problems to be solved. Students write their answers/solutions on paper and then take pictures and convert them to pdf files, using their smart phone. Then they submit their pdf files to the instructor using the e-class system. As an alternative, they can type their answers in word files and submit them using the e-class platform. Students are randomly separated in groups of five and each group is given different problems to solve. Problems and questions are given successively and not all of them together. Each problem/question is assigned the due response time. At the end of this time, students have to submit their answers. Then the next set of problems/questions is given with a defined response time. Students communicate with the instructors through the skype or skype for business platforms, operating in parallel with e-class. The instructors go through participant identification in the beginning and can check the participant's identity any time during the 3-hour duration of the exam. The degree of difficulty is higher than usual live participation examination. In order to participate, students have to solemnly declare through the university system that they agree with this type of examination. A list with the eligible student registration numbers and names is sent to the instructor before examination. The evaluation method is the same with student evaluation in normal circumstances presented above.

(1) Please write YES or NO

(2) Note down the evaluation methods used by the teacher, e.g.

- *written assignment* or/and exercises
- written or oral examination with distance learning methods, provided that the integrity and reliability of the examination are ensured.

(3) In the **Implementation Instructions** section, the teacher notes down clear instructions to the students:

a) in case of **written assignment and / or exercises:** the deadline (e.g. the last week of the semester), the means of submission, the grading system, the grade percentage of the assignment in the final grade and any other necessary information.

b) in case of **oral examination with distance learning methods:** the instructions for conducting the examination (e.g. in groups of X people), the way of administration of the questions to be answered, the distance learning platforms to be used, the technical means for the implementation of the examination (microphone, camera, word processor, internet connection, communication platform), the hyperlinks for the examination, the duration of the exam, the grading system, the percentage of the oral exam in the final grade, the ways in which the inviolability and reliability of the exam are ensured and any other necessary information.

c) in case of **written examination with distance learning methods**: the way of administration of the questions to be answered, the way of submitting the answers, the duration of the exam, the grading system, the percentage of the written exam of the exam in the final grade, the ways in which the integrity and reliability of the exam are ensured and any other necessary information.

There should be an attached list with the Student Registration Numbers only of students eligible to participate in the examination.