ETE817 – Advanced topics on the design of chemical industries and processes

COURSE OUTLINE

(1) GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	ETE817	**SEMESTER**	10th
COURSE TITLE	Advanced topics on the design of chemical industries and processes		

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	WEEKLY TEACHING HOURS	**CREDITS**
Lectures / Case Studies	3	3
Add rows if necessary. The organization of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE general background, special background, specialized general knowledge, skills development	Specialized knowledge on the design of chemical industries and processes
PREREQUISITE COURSES:	NO
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	LECTURES IN GREEK, PRESENTATION IN ENGLISH/GREEK
IS THE COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE WEBSITE (URL)	http://medlab.cc.uoi.gr/

(2) LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

Knowledge: The course “Advanced Topics on the Design of Chemical Industries and Processes” includes specialized lectures and laboratory exercises that build upon the undergraduate course “Design of Chemical Industries and Processes.” It serves as a natural continuation of that course, emphasizing the application of simulations in realistic industrial unit scenarios. Through the use of the DWSIM software, the students gain hands-on experience in the design and simulation of functional chemical plant units, focusing on:

- Selection of different types of chemical reactors and separation units.
- Evaluation, redesign, and optimization of existing production systems.
- Management and upgrading of by-products, waste, and surplus materials for reuse.
- Devices for cogeneration of electricity and other energy forms.
- Environmental parameters and regulatory considerations related to industrial installations.
- Analysis and selection of mechanical and electrical equipment (e.g., piping, pumps, valves, compressors, electric machines) and their structural materials.
- Installation, testing, and operation of industrial equipment.
- Preparation of a comprehensive technical and economic feasibility study for a production

unit.

Students learn to evaluate and redesign production facilities, select appropriate equipment, consider environmental and energy factors, and incorporate techno-economic decision-making.

By the end of the course, students will be able to:

- Interpret and construct realistic process flow diagrams for industrial production units
- Apply optimization techniques based on mass and energy balance models
- Analyze the operation of reactors and power cycles at an industrial scale
- Design sustainable and energy-efficient solutions that combine technical feasibility with economic evaluation

Teaching is conducted through theoretical lectures, laboratory work, and real-world engineering case studies.

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology
Adapting to new situations
Decision-making
Working independently
Team work
Working in an international environment
Working in an interdisciplinary environment
Production of new research ideas
Project planning and management
Respect for difference and multiculturalism
Respect for the natural environment
Showing social, professional and ethical responsibility and sensitivity to gender issues
Criticism and self-criticism
Production of free, creative and inductive thinking
……
Others…
…….

- Autonomous work.
- Teamwork.
- Project design and management.

(3) SYLLABUS

Topics:

- Advanced process flow design and integration of chemical production units.
- Design and sizing of distillation columns for realistic operational scenarios.
- Development of sustainable and efficient chemical reactors.
- Handling of nonlinear behavior in distillation systems.
- Selection and evaluation of advanced reactor and separation unit types.
- Redesign and optimization of existing industrial units.
- Design of cogeneration systems (e.g., organic Rankine cycles).
- Analysis of simple and complex installation options in chemical processes.
- Integration of environmental and regulatory parameters into design workflows.
- Selection of appropriate mechanical and electrical equipment.
- Preparation of a comprehensive techno-economic feasibility study for a proposed production unit.

Laboratory content:

The laboratory sessions utilize the DWSIM simulation environment to analyze and model complex chemical processes. The exercises include:

- Simulation of a toluene production unit (Lab Exercise 1).
- Simulation of an Organic Rankine Cycle (Lab Exercise 2).
- Simulation of a high-pressure CO_2 power generation unit (Lab Exercise 3).
- Simulation of a methanol production unit (Lab Exercise 4).
- Simulation of a cyclohexane production unit (Lab Exercise 5).
- Simulation of an ethyl chloride production unit (Lab Exercise 6).
- Simulation of a hydrogen production unit via the Water-Gas Shift Reaction (WGSR) (Lab Exercise 7).

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face in the class

USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY Use of ICT in teaching, laboratory education, communication with students	Advanced software for the design of chemical industries and processes (DWSIM – Open source chemical process simulator)
TEACHING METHODS *The manner and methods of teaching are described in detail. Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.* The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS	<table><tr><td>Activity</td><td>Semester workload</td></tr><tr><td>Lectures</td><td>26</td></tr><tr><td>Laboratory practice</td><td>13</td></tr><tr><td>Project</td><td>36</td></tr><tr><td>Course total</td><td>75</td></tr></table>
STUDENT PERFORMANCE EVALUATION Description of the evaluation procedure Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other Specifically-defined evaluation criteria are given, and if and where they are accessible to students.	Language of evaluation: Greek. Method of evaluation: Final examination of 2 hours duration (100% of the final grade), which involves the design of a complete chemical process flow diagram using the DWSIM software.

(5) ATTACHED BIBLIOGRAPHY

- *Suggested bibliography:*

– D. Marinos-Kouris, Z. Maroulis, Design of Chemical Industries, Papasotiriou 1993.
– M.S. Peters, K.D. Timmerhaus, R.E. West, Plant Design and Economics for Chemical Engineers, McGraw-Hill Education; 5 edition (December 9, 2002).
– G. Towler, R. K. Sinnott, Chemical Engineering Design: Principles, Practice and Economics of Plant and Process Design, Butterworth-Heinemann; 2nd edition, 2012
– R.Turton, R.Bailie, W.B. Whiting and J. Shaeiwitz, Analysis, Synthesis and Design of Chemical Processes, 4th Edition, Prentice Hall International Series 2012.
– J. Douglas, Conceptual Design of Chemical Processes, McGraw-Hill, 1988.
– R. Smith, Chemical Process Design and Integration, Wiley, 2005.
– W.D. Seider, J.D. Seader, J.D.,D.R. Lewin, S. Widagdo, Product and Process Design Principles, Wiley, 2010.