ETY410 - Heat and Mass Transfer Phenomena

COURSE OUTLINE

(1) GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	ETY410	**SEMESTER**	4
COURSE TITLE	Heat and Mass Transfer Phenomena		

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	4	4
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*	Special background	

PREREQUISITE COURSES:	-
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK
IS THE COURSE OFFERED TO ERASMUS STUDENTS	-
COURSE WEBSITE (URL)	

(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*

The aim of the course is to present the laws that govern heat and mass transfer processes, as well as the methods for calculating fundamental transport quantities. It provides the basic knowledge on which courses of further specialization of the Department will be built, such as Design of Physical and Chemical Processes, Design of Chemical Industries, and Design of Chemical Industries – Special Topics.

The course aims to familiarize students with heat and mass transfer, while connections with physicochemical and thermodynamic concepts are also highlighted (so that the material is also compatible with the background offered in departments of Chemical Engineering, Metallurgy, Chemistry, etc.).

Knowledge: The aim of the course is to educate students in heat and mass transfer. For heat

transfer, with the temperature difference as the driving force, and for mass transfer, with the concentration difference as the driving force, the student is expected to understand the basic principles and the different transfer mechanisms, as well as the physical meaning of the various constants and parameters used in solving problems.

Skills: The student should be able to set up and solve heat and mass transfer problems in steady and unsteady state and to simplify complex transfer phenomena into simpler ones. Students learn to set up differential equations based on the balances and, using correct boundary conditions, to calculate mass and heat transfer rates as well as the concentration and temperature profiles of a system.

Ability: Using their theoretical knowledge and skills in solving heat and mass transfer problems, the student will be able to make the required assumptions and simplifications and to make choices for the design and development of complex transfer systems.

Upon successful completion of the course the following learning outcomes are pursued:

- The student will have demonstrably adequate theoretical knowledge of the subject, so as to understand the basic mechanisms of heat and mass transfer at the macroscopic level. The student will understand and handle the analytical solutions of basic one-dimensional and multidimensional problems.
- The students will broaden their horizons regarding technological problems related to the subject and will acquire the ability to solve analytically and numerically (where deemed necessary) steady-state and transient problems.
- The student will acquire the skill to model practical heat and mass transfer problems, that is, to analyze a real problem and to choose appropriately the PDE, the boundary conditions and the initial conditions. In other words, to compose a mathematical model that corresponds to the problem.

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

- Independent work
- Production of free, creative and inductive thinking
- Search, analysis and synthesis of data and information, with the use of the necessary technologies
- Ability to convert physical problems into corresponding mathematical-computational problems.

(3) SYLLABUS

Introduction to thermodynamics and heat transfer: heat transfer in engineering, heat and other forms of energy, the first law of thermodynamics. Heat transfer mechanisms: conduction, convection, radiation, simultaneous heat transfer mechanisms. The heat conduction equation: introduction, one-dimensional heat conduction equation, general heat conduction equation, boundary and initial conditions, solution of one-dimensional steady conduction problems, heat generation in a solid, variable thermal conductivity. Steady heat conduction: steady conduction in plane walls, thermal contact resistance, generalized thermal resistance networks, heat conduction in cylinders and spheres, critical radius of insulation, heat transfer from finned surfaces, the bioheat equation, heat transfer in common configurations. Unsteady (transient) heat conduction: lumped system analysis, transient conduction in large plane walls, long

cylinders and spheres with spatial effects, transient conduction in semi-infinite solids, transient conduction in multidimensional systems. Numerical methods in heat conduction.
Introduction to mass transfer. Analogies between heat transfer and mass transfer. Mass diffusion. Boundary conditions. Steady diffusion through a wall. Diffusion of water vapor through building elements. Transient mass transfer. Diffusion in a moving medium. Mass convection. Simultaneous heat and mass transfer.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	The theoretical part of the course is taught on the board. A video projector is used mainly for the graphical presentation of the results of one-dimensional and multidimensional problems.
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*	

Activity	*Semester workload*
Lectures	39
Exercises – Problems	13
Non-directed study of the student and preparation for the final examination of the course	48
Course total	100

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: The evaluation is based mainly on the final written examination held during the examination periods.

(5) ATTACHED BIBLIOGRAPHY

-Suggested bibliography:

- Cengel Yunus, Ghajar Afshin, Heat and Mass Transfer, 7th Edition, Tziola Publications, 2026.
- Koukos Ioannis, Introduction to Heat and Mass Transfer, University of Patras Publications.