COURSE OUTLINE

(1) GENERAL

SCHOOL	School of Engineering		
ACADEMIC UNIT	Mechanical Engineering		
LEVEL OF STUDIES	Undergraduate		
COURSE CODE	EN0301	**SEMESTER**	5th
COURSE TITLE	Heat Transfer		

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	5	6
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialized general knowledge, skills development*	Background
PREREQUISITE COURSES:	There are no prerequisite courses. It is recommended that students who are interested in attending the course have completed successfully the following courses: Ordinary Differential Equations, Thermodynamics I & II, Fluid Mechanics I.
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	No
COURSE WEBSITE (URL)	https://www.mie.uth.gr/?page_id=17896

(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 goal of this course is to introduce the student to the fundamental principles of heat transfer via conduction, convection and radiation and to familiarize him/her with basic calculations towards the prediction of heat transfer rates in the framework of the laws of thermodynamics. Upon successful completion of the course the student will be able to:

- Perform simple calculations using the equivalence between electric circuits and one-dimensional steady heat conduction, including different finned geometries with constant and varying surfaces
- Analyze steady and transient heat conduction in zero, one and two-dimensional geometries employing classical techniques for the solution of partial differential equations, aiming at specific applications from the fields of cooling of food, electronic circuits and buildings
- Analyze heat transfer via forced convection in planar and curved geometries using concepts from the boundary layer theory and employing the analogy with momentum transfer for laminar and turbulent flow, in the context of open and closed flow arrangements
- Analyze heat transfer via free convection in different geometries, employing the analogy with momentum transfer for laminar and turbulent free convection flow
- Apply the above concepts of heat convection in applications such as the design and optimization of heat exchangers and the cooling of electric circuits via finned surfaces

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	*Project planning and management* *Respect for difference and multiculturalism*

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*	*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...* *.......*

- Search for analysis and synthesis of data and information by combining theoretical concepts and physical models.
- Employ established techniques from mathematical physics in order to obtain simplified solutions of model problems
- Production of critical, creative and inductive thinking towards associating the fundamental concepts with specific applications from the fields of cooling of food, buildings electric circuits and bioheat transfer

(3) SYLLABUS

- Setting up of energy balances for closed systems and control volumes. Conservation of thermal energy in the context of the first law of thermodynamics
- Presentation of the three mechanisms for heat transfer, i.e. conduction convection and radiation, and identification of the relevant physical properties – Fourier, Newton and Stefan-Boltzmann laws - Solution of simple model cases associated with practical applications
- One dimensional heat conduction in cartesian, cylindrical and spherical coordinates – Critical radius of insulation - Solution of multilayered structures and thermal resistance networks using the analogy with electric circuits – Heat transfer from finned surfaces – Efficiency, effectiveness and the proper length of fins – Bioheat transfer equation
- Two dimensional heat conduction for the calculation of thermal shape factor in different geometries using mathematical methods from potential theory and the method of separation of variables in different coordinate systems
- Transient heat conduction in lumped, one two and three dimensional systems – Solution for finite and semi-infinite solids using the methods of separation of variables and Laplace transform
- Convection heat transfer – Concept of boundary layer in fluid flows – Thermal boundary layer – Solution of coupled laminar heat and momentum transfer past a flat plate and the concept of analogy between heat and momentum transfer – Reynolds and Peclet numbers - Friction factor and the Nusselt number
- Heat and momentum transfer in turbulent flow – Heat transfer via external and internal forced convection – Drag and heat transfer in external flow – Laminar and turbulent flow and heat transfer in tubes – Application in the design of heat exchangers
- Physical mechanism of natural convection – Equation of motion and the Grashof number- Natural convection over finned surfaces and inside enclosures

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY ***Face-to-face, Distance learning, etc.***	Face to face (class)
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Support of the learning process with material that is uploaded on the internet site of the course
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*	(see table below)

Activity	*Semester workload*
Lectures	70
Homework	30
Study at home	50
Course total	*150*

principles of the ECTS	Course total (25 hours of work load per unit of credit)	

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.*	Written exam (70%) Midterm Exam (30%) The evaluation criteria may vary among different academic years but on average they follow the above distribution. In any case they the students are notified regarding the evaluation procedure in the beginning of each semester and the specific criteria are uploaded on the course's web page in the Department's internet site.

(5) ATTACHED BIBLIOGRAPHY

-Suggested bibliography:

- Y.A. Cengel & A.J. Ghajar Μεταφορά Μάζας και Θερμότητας – Βασικές Αρχές & Εφαρμογές, 5η Έκδοση, Εκδ. Τζιόλα, 2018.
- T.L. Bergman, A.S. Lavine, F.P. Incropera and D.P. DeWitt, Introduction to Heat Transfer, John Wiley & Sons, 6th Ed. 2011.
- Holman J.P., "Heat Transfer", 8th Ed., McGraw Hill, 1997
- Ν. Σ. Μουσιόπουλος, "Εισαγωγή στην Μετάδοση Θερμότητας", Γιαχούδη - Γιαπούλη, Θεσ/νίκη, 1991
- Κ. Ρακόπουλος, "Μεταφορά Θερμότητας & Μάζας", Πλαίσιο, 1985
- V. Arpaci, Conduction Heat Transfer, Addison Wesley, 1966.
- V. Arpaci & P. S. Larsen, Convection Heat Transfer, Prentice-Hall Inc., 1984.

- Related academic journals:

- Journal of Fluid Mechanics
- International Journal of Heat and Mass Transfer
- Physics of fluids
- Journal of Computational Physics