Course Title	Heat Transfer				
Course Code	ME 304				
Course Type	Compulsory				
Level	BSc Level				
Year / Semester	3rd year / 5th semester				
Teacher's Name	Dr.-Ing. Paris A. Fokaides				
ECTS	6	Lectures / week	3	Laboratories/week	1
Course Purpose	Heat transfer is a discipline of thermal engineering that concerns the generation, use, conversion, and exchange of thermal energy (heat) between physical systems. Heat transfer is classified into various mechanisms, including thermal conduction, thermal convection, thermal radiation, Heat transfer plays a major role in the design of many devices, such as various components of power plants, renewable energy technologies, HVAC equipment, buildings energy design, automotive engineering and aerospace equipment, etc. The purpose of this lecture is to introduce the students in the main concepts and principles which are related to heat transfer. On completion of this course, the students will be able to develop the fundamental principles and laws of heat transfer and to explore the implications of these principles for system behaviour. This course also aims to provide the required knowledge to the students to formulate the models necessary to study, analyse and design heat transfer systems through the application of heat transfer principles. The students will also develop the problem-solving skills essential to good engineering practice of heat transfer in real-world applications. The course will cover the three modes of heat transfer namely conduction, convection and radiation in detail, as well as applications related to condensation and boiling. In terms of this course mass transfer phenomena will also be introduced and elaborated. These modes will be explained through descriptions and illustrations as well as through numerous worked examples and laboratory exercises. The underlying physics that define these phenomena will also be explained.				
Learning Outcomes	1. Explain the fundamental concepts of thermodynamics that form the framework for heat transfer and describe the three basic mechanisms of heat transfer. 2. Classify steady, unsteady, and multidimensional heat conduction and derive the differential equation that governs heat conduction in large plane walls, long cylinders, and spheres				

	3. Assess one-dimensional steady heat conduction in plane walls, cylinders, and spheres, and develop relations for thermal resistances in these geometries for conduction and for convection and radiation conditions at the boundaries. 4. Calculate temperature variation in lumped systems and the variation of temperature in time and space for one-dimensional heat conduction problems associated with large plane walls, long cylinders, spheres, and semi-infinite mediums using transient temperature charts and analytical solutions. 5. Explain the dimensionless Reynolds, Prandtl, and Nusselt numbers, and their physical significance and derive the convection equations on the basis of mass, momentum, and energy conservation 6. Apply the Newton's cooling law and the proper Nusselt numbers to calculate heat transfer for laminar and turbulent flows over flat plates, spheres, cylinders and in tubes. 7. Understand the physical mechanism of natural convection and the Grashof number and evaluate heat transfer by natural convection for various geometries. 8. Interpret the boiling curve and the modes of pool boiling and calculate the condensation rate in the presence of forced convection, as well as film condensation in several geometrical arrangements and orientations. 9. Solve radiation problems using the blackbody radiation function, together with the Stefan–Boltzmann law, Planck's law, and Wien's displacement law and the radiative properties of materials. 10. Demonstrate analogies between heat and mass transfer and discuss boundary conditions associated with mass transfer and one-dimensional steady and transient mass diffusion.		
Prerequisites	ME 200 Thermodynamics I ME 202 Fluid Mechanics I	Corequisites	
Course Content	**1. Introduction – Basics of Heat Transfer** - Heat transfer applications - Heat transfer mechanisms - Problem solving techniques **2. Fundamentals of Heat Conduction** - Steady versus transient heat transfer - Multidimensional heat transfer - Heat generation - One dimensional heat conduction equation **3. Steady Heat Conduction** - Steady heat conduction in plane walls - The thermal resistance concept - Heat conduction in cylinders and spheres - Heat transfer between two solids (Shape factor) **4. Transient Heat Conduction** - Lumped system analysis - Transient heat conduction with spatial effect		

	- Transient heat transfer in multi-dimensional systems **5. Fundamentals of Heat Convection** - Physical mechanisms of convection - Classification of fluid flows - Velocity and thermal boundary layer - Laminar and turbulent flows **6. Forced Convection** - Parallel flow over flat plates - Flow across cylinders and spheres - Laminar flows in tubes - Turbulent flows in tubes **7. Natural Convection** - Physical mechanism of natural convection - Equation of motion - Natural convection over surfaces - Natural convection inside enclosures - Combined natural and forced convection **8. Fundamentals of Thermal Radiation** - The view factor - Radiation heat transfer: black surfaces - Radiation heat transfer: diffuse and gray surfaces - Radiation shields - Emissivity and absorptivity of gases **9. Boiling and Condensation** - Boiling heat transfer - Condensation heat transfer **10. Mass Transfer Principles** - Analogy between heat and mass transfer - Fick's law of diffusion - Boundary conditions - Steady mass diffusion through a wall - Water vapor migration in buildings **11. Transient Mass Transfer** - Transient mass diffusion - Diffusion in a moving medium - Mass convection - Simultaneous heat and mass transfer **Laboratory Exercises:** 1. Determination of the Specific Heat Capacity 2. Determining the thermal conductivity of materials using the single-plate and flux plate methods 3. Forced convection over flat plates, plates with fins and plates with rods 4. Free convection over flat plates, plates with fins and plates with rods 5. Thermal Radiation System 6. Radiation intensity and thermoelectric Converter
Teaching Methodology	The teaching methodology of this course will be based on lecturing, demonstrating and collaborating.

	- Lecture notes, comprising of the fundamentals of each module of the course will be prepared and presented in class on a weekly basis. The notes will introduce the major concepts and will focus on specific learning outcomes of the course. - Demonstration activities including the solution of worked examples in class on a weekly basis, as well as laboratorial work will also be employed. For each fundamental concept, at least one worked example will be solved during lectures. The laboratory work will cover all major topics of the course, allowing the students to personally relate to the presented knowledge. - Collaborating teaching through classroom discussion and debriefing will also be encouraged during lectures. Besides from the notes taken by students in class, all of the course material will be made available through the class website and also through the eLearning platform. The instructor will also be available to students during office hours or by appointment in order to provide any necessary tutoring.
Bibliography	Textbook: Cengel, Y. A., & Ghajar, A. J. (2011). Heat and mass transfer (a practical approach, SI version). McGraw-Hill Education. References: Selected scientific papers from following journals: - International Journal of Heat and Mass Transfer – Elsevier - Heat and Mass Transfer – Springer - Heat Transfer Engineering – Taylor and Francis - Journal of Heat Transfer - ASME
Assessment	Students will be assessed through: - Biweekly quiz concerning the laboratory exercises - A midterm test at the 7th week of the course, examining the fundamentals of conduction and convection - A final test at the end of the semester, in which all material will be examined. The weights of the course assessment are as follows: Lab Quiz: 20% Midterm Exams: 20% Final Exams: 60%
Language	English