Course Title	Transport Phenomena				
Course Code	ME 434				
Course Type	Elective				
Level	BSc Level				
Year / Semester	4th year / 8th semester				
Teacher's Name	Dr.-Ing. Paris A. Fokaides				
ECTS	6	Lectures / week	3	Laboratories/week	1
Course Purpose	In this course we derive the differential equations of fluid motion, namely, conservation of mass (the continuity equation) and Newton's second law the Navier–Stokes equation). These equations apply to every point in the flow field and thus enable us to solve for all details of the flow everywhere in the flow domain. We provide a step-by-step procedure for solving this set of differential equations of fluid motion and obtain analytical solutions for several simple examples. We also introduce the concept of the stream function; curves of constant stream function turn out to be streamlines in two-dimensional flow fields. We also look at several approximations that eliminate term(s), reducing the Navier–Stokes equation to a simplified form that is more easily solvable. We consider creeping flow, where the Reynolds number is so low that the viscous terms dominate (and eliminate) the inertial terms. Following that, we look at two approximations that are appropriate in regions of flow away from walls and wakes: inviscid flow and irrotational flow (also called potential flow). In these regions, the opposite holds; i.e., inertial terms dominate viscous terms. Finally, we discuss the boundary layer approximation, in which both inertial and viscous terms remain, but some of the viscous terms are negligible.				
Learning Outcomes	1. Analyze the conservation of mass equation 2. Derive the mass contninuity equation for cylindrical coordinates 3. Apply the stream function in cartesian and cylindrical coordinates 4. Calculate the derivation using the divergence theorem 5. Derive the conservation linear momentum with the use of the newton's second law 6. Produce the Navier-Stokes equation for cartesian and cylindrical coordinates 7. Calculate the pressure field for known velocity fields 8. Derive of the Bernoulli Equation in Inviscid Regions of Flow 9. Produce the Bernoulli Equation in Irrotational Regions of Flow				
Prerequisites	ME 200 Thermodynamics I		Corequisites	-	

	ME 202 Fluid Mechanics I ME 304 Heat Transfer		
Course Content	**1. Conservation of Mass—The Continuity Equation** - Derivation Using the Divergence Theorem - Derivation Using an Infinitesimal Control Volume - Alternative Form of the Continuity Equation - Continuity Equation in Cylindrical Coordinates - Special Cases of the Continuity Equation **2. The Stream Function** - The Stream Function in Cartesian Coordinates - The Stream Function in Cylindrical Coordinates - The Compressible Stream Function **3. Conservation of Linear Momentum—Cauchy's Equation** - Derivation Using the Divergence Theorem - Derivation Using an Infinitesimal Control Volume - Alternative Form of Cauchy's Equation - Derivation Using Newton's Second Law **4. The Navier–Stokes Equation** - Newtonian versus Non-Newtonian Fluids - Derivation of the Navier–Stokes Equation for Incompressible, Isothermal Flow - Continuity and Navier–Stokes Equations in Cartesian Coordinates - Continuity and Navier–Stokes Equations in Cylindrical Coordinates **5. Differential Analysis of Fluid Flow Problems** - Calculation of the Pressure Field for a Known Velocity Field - Exact Solutions of the Continuity and Navier–Stokes Equations		

	6. Approximate Solutions of the Navier-Stokes Equation - Nondimensionalized Equations of Motion - The Creeping Flow Approximation - Drag on a Sphere in Creeping Flow - Approximation for Inviscid Regions of Flow - Derivation of the Bernoulli Equation in Inviscid Regions of Flow - The Irrotational Flow Approximation - Derivation of the Bernoulli Equation in Irrotational Regions of Flow - The Boundary Layer ApproximationDerivation Using the Divergence Theorem
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: Çengel, Y. A., Turner, R. H., & Cimbala, J. M. (2001). Fundamentals of thermal-fluid sciences (Vol. 703). New York: McGraw-Hill.
Assessment	Students will be assessed through: - A midterm test at the 7th week of the course, examining the Conservation of Mass-The Continuity Equation, the Stream Function and the conserviation of linear momentum. - A semester personal assignment

	- 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: Assignment: 20% Midterm Exams: 20% Final Exams: 60%
Language	English