Course unit title:	Transport Phenomena		
Course unit code:	ME 434		
Type of course unit:	Compulsory – Oil and Gas Stream		
Level of course unit:	Bachelor (1st Cycle)		
Year of study:	4		
Semester when the unit is delivered:	8		
Number of ECTS credits allocated :	6		
Name of lecturer(s):	Dr. Paris Fokaides		
Learning outcomes of the course unit:	▪ 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.		
Mode of delivery:	Face-to-face		
Prerequisites:	ME304, ME202, ME200	Co-requisites:	None
Recommended optional program components:	None		
Course contents:	**Module 01: 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 **Module 02: The Stream Function** ▪ The Stream Function in Cartesian Coordinates ▪ The Stream Function in Cylindrical Coordinates ▪ The Compressible Stream Function **Module 03: 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 **Module 04: 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 **Module 05: 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 **Module 06: 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
Recommended and/or required reading:	**Fluid mechanics : fundamentals and applications** / Yunus A. Çengel, John M. Cimbala.—1st ed., McGraw-Hill series in mechanical engineering
Textbooks:	R. Byron Bird, Warren E. Stewart, Edwin N. Lightfoot, ***Transport Phenomena***, John Wiley & Sons, Inc.; 2nd edition (December 11, 2006)
References:	T.L. Bergman, F.P. Incropera, A.S. Lavine, D.P. DeWitt, ***Fundamentals of Heat and Mass Transfer,*** John Wiley & Sons, 2011
Planned learning activities and teaching methods:	The taught part of course is delivered to the students by means of lectures, conducted with the help of computer presentations. Lecture notes and presentations are available through the web for students to use in combination with the textbooks. Lectures are supplemented with laboratory sessions with aim to get acquainted with lab equipment and instruments for measuring temperatures, specific heat capacities, thermal conductivities and other thermal properties.
Assessment methods and criteria:	• Tests: 50% • Final Exam 50%
Language of instruction:	English
Work placement(s):	No