Course unit title:	**Industrial modelling and simulation**
Course unit code:	OG404
Type of course unit:	Compulsory
Level of course unit:	Bachelor (1st Cycle)
Year of study:	4
Semester when the unit is delivered:	8(Spring)
Number of ECTS credits allocated :	6
Name of lecturer(s):	Dr. Charalambos Chasos
Learning outcomes of the course unit:	1. Formulate and solve fluid flow and heat transfer problems with the use of computational fluid dynamics codes, and compare fluid flow and heat transfer behaviour in various geometries for wide range of conditions. 2. Identify and use methodologies for modelling, simulations and carrying out parametric studies for the design and development of thermal and/or fluid flow systems and/or process systems. 3. Formulate flowsheets of industrial processes such as oil and gas processing and familiarise with commercial process simulators. 4. Describe the design of process systems and relate with data obtained from process simulators. 5. Implement equations in computer programmes and solve numerically fluid flow, heat transfer and process systems problems.
Mode of delivery:	Face-to-face
Prerequisites:	ME200, ME202 — Co-requisites: None
Recommended optional program components:	None
Course contents:	**Part A: Flow processes modelling and simulations** **Classification of fluid flow and heat transfer problems**: Steady and unsteady state problems. Inviscid and viscous flow. Laminar and turbulent flow. Incompressible and compressible flow. Multiphase flows. Summary of problem types and equations. **Conservation equations for fluid flow and heat transfer:** Mass, momentum and energy conservation equations differential and integral form. Discretisation techniques: The finite-difference method. The finite-volume method and differencing schemes. Boundary conditions for steady and unsteady flows. Initial conditions for unsteady flows. Solution techniques of discretised equations: direct methods and indirect methods. **Computational fluid dynamics (CFD) codes:** industrial applications with commercial codes. Problems formulation and computer programming solution with programming language (FORTRAN or MATLAB). Complex geometry grid generation. The Navier-Stokes equations and turbulence modelling equations averaging. Large Eddy Simulation (LES). Direct numerical simulation (DNS). **Part B: Industrial processes modelling and simulations** **Classification of industrial processes**: Chemical reactor systems, separation systems, compression systems and heat exchangers. Practical examples (flash distillation, extraction, gas absorption and adsorption). Aspects of design and integration of various process systems. Energy and environmental concepts in industrial processes. **Process modelling approach**: Equations of state, thermophysical properties models, vapor/liquid equilibrium equations, chemical reaction equations, mass and energy balances. Process heat transfer equations. Aspects of processes flowsheet formulation.

	Process simulation: Steady state calculations approach with commercial simulator tools application and implementation of processes flowsheets. Data visualisation and analysis. Performance and efficiency assessment from process simulations. Introduction in dynamic process simulations. **Laboratories:** Individual simulation Laboratories for industrial fluid flow and heat problem with the use of state-of-the-art commercial CFD code at the Computer Laboratory. Individual process simulation problem with the use of state-of-the-art commercial process simulator at the Computer Laboratory. **Assignments:** Individual assignment for fluid flow and heat transfer problem with the finite-volume method. Individual assignment for solving the equilibrium equations for a flash phase separator example. Assignments solution with the use of programming language (FORTRAN or MATLAB).
Recommended and/or required reading:	
Textbooks:	1. Versteeg H. K. and Malalasekera, W. "***An introduction to Computational Fluid Dynamics – The Finite-Volume Method***". 2nd Edition, Prentice Hall, England, 2. Ferziger, J. H and Peric, M. "***Computational Methods for Fluid Dynamics***". 2nd Edition,Springer, Germany, 1999. 3. Incropera, F. P. and DeWitt, D. P. "***Fundamentals of heat and mass transfer***", 5th Edition, John Wiley & Sons, USA, 2002 4. Crowe, C., Sommerfeld, M. and Tsuji, Y. "***Multiphase flows with droplets and particles***", CRC Press, USA, 1998. 5. Ellis, T. M. R. "***A structured approach to FORTRAN 77 programming***". Addison-Wesley, England, 1982 6. Finlayson, B. A. "***Introduction to chemical engineering computing***", 2nd Edition, John Wiley & Sons Inc., USA, 2012. 7. Smith, R. "***Chemical process design and integration***", John Wiley & Sons Ltd, England, 2005. 8. Biran, A. and Breiner M. "***MATLAB 6 for engineers***", 3rd Edition, Prentice Hall, 2002
Planned learning activities and teaching methods:	The course is delivered to the students by means of lectures, conducted with the help of computer presentations, as well as demonstrations of computational models, computer programmes and the use of advanced CFD code and Process Simulators at the computer laboratory. Lecture notes and presentations are available through the web for students to use in combination with the textbooks.
Assessment methods and criteria:	• Assignments 10% • Laboratories 10% • Test 20% • Final Exam 60%
Language of instruction:	English
Work placement(s):	No