Freie Universität Bozen
Libera Università di Bolzano
Università Liedia de Bulsan

# Syllabus
# Course description

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| **Course title** | Advanced Methods for Fluid Machine Design |
| **Course code** | 42157 |
| **Scientific sector** | ING-IND/08 |
| **Degree** | Bachelor in Industrial and Mechanical Engineering |
| **Semester** | II |
| **Year** | /// |
| **Academic year** | 2019/20 |
| **Credits** | 6 |
| **Modular** | No |

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| **Total lecturing hours** | 36 |
| **Total lab hours** | |
| **Total exercise hours** | 24 |
| **Attendance** | Not compulsory, but strongly suggested |
| **Prerequisites** | Fundamentals of Fluid Machines course |
| **Course page** | |

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| **Specific educational objectives** | The course of Advanced Methods for Fluid Machine Design is a compulsory course for the curriculum in Energy in the Bachelor of Industrial and Mechanical Engineering and it is an elective course for all the other curricula. The course is in the scientific sector of Fluid Machines and it consists of 36 hours of frontal lectures and 24 hours of practical exercises.<br><br>The course aims to introduce students to the use of the numerical analysis for the study of complex fluid flow-fields that can be found in turbomachinery and in propulsion systems, making use of the Finite Volumes Methodology (FVM).<br><br>Specific educational objectives:<br>- understanding the theoretical aspects underlying computational fluid dynamics (CFD);<br>- comprehension of the numerical algorithms for the discrete resolution of compressible and incompressible flows;<br>- understanding the basic principles and approaches to modeling turbulence;<br>- acquire the fundamental knowledge for a correct choice of numerical models, boundary conditions and interfaces<br>- acquire the fundamental knowledge for the use of commercial calculation codes for geometric modeling, grid generation, fluid dynamic resolution or analysis |

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| **Lecturer** | Dr. Briola Stefano |
| **Scientific sector of the lecturer** | |
| **Teaching language** | English |
| **Office hours** | Friday from 12-14 |
| **Teaching assistant (if any )** | |
| **Office hours** | |
| **List of topics covered** | The course aims to provide an introduction to the use of numerical resolution tools for fluid-dynamics problems in Fluid Machines.<br>A first theoretical part will provide the basic knowledge on the numerical solution of ordinary differential equations and partial differential equations. The second part will deal with the fundamental equations of fluid dynamics and the numerical methods used in commercial fluid-dynamics calculation software. Spatial Discretization: Solution principles of fluid dynamics equations; Finite Volumes Method (FVM).<br>The turbulence modelling and the boundary layer modelling are briefly presented.<br>A significant part of the course foresees practical exercises involving the use of computer software for grid generation and numerical resolution. Specific attention will be focused on the application of the numerical codes to turbomachines or volumetric machines. |
| **Teaching format** | The course has a duration of 60 hours, 36 hours of frontal teaching and 24 hours of exercises. The lectures on the theory part are presented at the blackboard and using slides. The exercises consist in the guided numerical resolution of differential equations and of more complex problems of numerical fluid dynamics applied to industrial flows and turbomachines. The exercises will be carried out with PCs using numerical commercial software. |

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| **Learning outcomes** | The learning outcomes referred to the Dublin Descriptors:<br><br>**Knowledge and understanding**<br>The course allows the students to acquire advanced knowledge on the main numerical methods for the advanced study of the fluid-dynamics in Fluid Machines (1). The topics discussed will provide the basis for a thorough understanding of the main physical phenomena, approaches for the modeling (2), comprehension of the numerical methods (3) with specific focus on turbomachines.<br><br>**Applying knowledge and understanding**<br>The student will be able to apply the knowledge during the exercises where the studied models will be used to |

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| | assess specific practical problems (4). They will also apply the theoretical contents by using commercial calculation codes for geometric modeling, grid generation, fluid dynamic resolution or analysis of results (5).<br><br>**Making judgments**<br>The student should acquire the ability to evaluate the best choice of numerical models and boundary conditions applied to important practical cases in industrial flows and turbomachines (6). The student should also be able to discuss and interpret the numerical results and correlate them with the physical problem (7).<br><br>**Communication skills**<br>The student should acquire the proper technical language (8) and should be able to present the design choices, the numerical results with a critical approach (9).<br><br>**Learning skills**<br>The student should acquire lifelong learning skills through the possession of the tools for the numerical modeling and to update knowledge (10). Moreover, the student should be able to get the required data and information from databases, technical and scientific papers (11). |

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| **Assessment** | The final exam consists in an oral exam on the theoretical concepts and the discussion of a project work in which the concepts of the course are applied to an industrial flow or a turbomachine or a volumetric machine. Students are expected to prepare a report on the case study; the discussion of the project work and its presentation can be made in group of students (maximum 2 students per project). |
| **Assessment language** | English |

**Formative assessment**

| Form | Length / duration | ILOs assessed |
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| In class exercises | 24 X 120 minutes | 4, 5, 6, 7 |

**Summative assessment**

| Form | % | Length / duration | ILOs assessed |
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| Oral exam – theory | 50% | 2 or 3 open-end questions (about hour) | 1, 2, 3, 8, |
| Project work presentation | 50% | Presentation and discussion (30 minutes) | 4, 5, 6, 7, 9, 10, 11 |

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| **Evaluation criteria and criteria for awarding marks** | The student must demonstrate to have acquired the physical principles and theoretical-evaluation consideration; moreover, the student must show the ability to apply the knowledge in practical test cases.<br><br>In order to get a positive final mark, the student must demonstrate that there are no gaps in the basic knowledge presented in the course. The maximum evaluation is achieved by demonstrating in-depth knowledge of course content. The oral questions and the quality of the report have the same weight in the final mark calculation.<br>For the evaluation of the oral exam the following criteria will be taken into account:<br>- Ability to describe the numerical methods to solve fluid dynamic problems in fluid machines<br>- Ability to describe the issues of the volume discretization of the numerical problem<br>- Ability to define the correct boundary conditions<br>- Ability to provide examples/applications of the theoretical concepts<br>- Proper use of the technical language<br><br>For the evaluation of the project work, the determination of the final mark takes into account:<br>- Adequacy of the approach to the solution of the problem<br>- Clarity in the presentation and discussion of the results<br>- Proper use of the technical language |

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| **Required readings** | The slides presented during the lectures will be available in the reserve collection. Any additional required material will be supplied during the lectures and made available in the reserve collection. |
| **Supplementary readings** | Additional readings available in the University Library:<br>- Fondamenti di calcolo numerico, Giovanni Monegato, Editore CLUT, ISBN: 887992138X<br>- An Introduction to Computational Fluid Dynamics: the Finite Volume Method, H K Versteeg and W. Malalasekera, Ed. Person Prentice Hal, ISBN 9780131274983<br>- Computational Methods for Fluid Dynamics, JH Ferziger and M Peric, Ed. Springer, ISBN 978-3-642-56026-2 |