Course name	**Computational Fluid Dynamics**	*Code*		*Credit points*	**3**

Language of instruction **English**

Programme Computer Modelling and Simulation (CMS), Intelligent Energy (IE), Biotechnology for Environmental Protection (BI), Bussiness and Technology (BT)*

Type of studies BSc studies*

Unit running the programme Institute of Thermal Machinery

Course coordinator and academic teachers Andrzej Bogusławski, Assoc. Prof., Dariusz Asendrych, Ph.D., Artur Tyliszczak , Ph.D

Form of classes and number of hours

Semester	Lec.	Tut.	Lab.	Proj.	Sem.	Credit points
VII	30E		30			3

Learning outcomes

** The outcome of the course is the ability of the student to understand the basics of numerical approach to fluid dynamics problems, starting with simple examples of the flow governed by ordinary differential equations like free falling body in a viscous medium or motion of elastically fixed wing. Then fundamentals of potential flows are discussed and numerical approach including conformal method and panel methods. Finally an introduction to finite differences is presented using one-dimensional convection-diffusion equation as an example. The discretization in space is shown leading to the set of linear algebraic equations. The simplest numerical approaches to linear systems are discussed. The application of finite difference method is shown on two-dimensional problem of potential flow in complex geometry cavity and compressible one-dimensional flow in converging-diverging nozzle

Prerequisites (courses)

Prerequisites (mathematical tools) Basic knowledge of differential and integration calculus, basic knowledge on ordinary and partial differential equations, concept of energy, work and heat,

Course description

LECTURE:

Numerical methods for ordinary differential equations: existence and uniqueness of solution, classification of solution methods – single and multi-step methods, explicit and implicit methods, numerical errors, Taylor series expansion approach, Runge-Kutta methods, multi-step methods – Adams-Bashforth and Adams Moulton, stability and convergence

Numerical methods for potential flows: concept of potential flows, basic types of potential flows, complex potential, superposition principle, conformal mapping, Joukowsky transformation, Christoffel-Schwarz method, source panel method, vortex

	panel method **Finiet difference method in Computer Fluid Dynamics:** Classification of second order partial differential equations, finite differences, numerical solution of linear systems – direct and iterative methods, solution of one-dimensional convection-diffusion equation – upwind corrected schemes, Lax-Wendroff and MacCormack methods TUTORIALS:Not applicable LABORATORY: **Application of numerical methods for ODE –** development of C- code solving ODE with single - and multistep methods **Examples of applications of ODE in fluid dynamics:** Solution of the set of equations of motion for free falling body and elastically fixed wing **Numerical methods for potential flows:** development of the C-code for Joukowsky transformation leading to pressure distribution and lift force for Joukowsky aerofoil, Development of the C-code for source panel method - calculation of the flow field around a set of circular cylinders, development of the C-code for the vortex panel method applied to symmetric aerofoil **Finiet difference method in Computer Fluid Dynamics:** development of the C-code solving with finite differences the potential flow in a complex geometry cavity, application of the Lax-Wendroff and/or MacCormack scheme to one-dimensional flow through the converging-diverging nozzle PROJECT: Not applicable SEMINAR: Not applicable
Form of assessment	Exam
Basic reference materials	*** 1. Wesseling P. , Principles of Computational Fluid Dynamics, Springer, 2001 2. Ferziger,J.H., Peric, M., Computational Methods for Fluid Dynamics, Spinger, 2002 3. Chow : Introduction to Computational Fluid Mechanics, 4. Wendt F.W.: Computational Fluid Dynamics, Springer-Verlag, 1992 5. Stroustrup B.: The C++ Programming Language, 6. Bogusławski A., Tyliszczak A., Introduction to CFD, Politechnika Częstochowska, skrypt, 2009
Other reference materials	For Polish-speaking students:

e-mail of the course coordinator and academic teachers	abogus@imc.pcz.czest.pl; darek@imc.pcz.czest.pl; atyl@imc.pcz.czest.pl
Average student workload (teaching hours + individ.)	4 teaching hours +3 hours of individual work per week
Remarks:	
Updated on: 12.06. 2009	