SYLLABUS[1]

1. Information about the program

1.1 Higher education institution	University Politehnica Timisoara
1.2 Faculty[2] / Department[3]	Mechanical Engineering/MMUT
1.3 Chair	—
1.4 Field of study (name/code[4])	Mechanical Engineering/20.70.10
1.5 Study cycle	Master
1.6 Study program (name/code/qualification)	Hydrodynamics of machines and hydromechanic systems/20.70.10.10.

2. Information about the discipline

2.1 Name of discipline			Numerical methods for heat and fluid flow				
2.2 Coordinator (holder) of course activities			Prof.dr.ing. Romeo SUSAN-RESIGA				
2.3 Coordinator (holder) of applied activities [5]			S.l.dr.ing. Adrian STUPARU				
2.4 Year of study[6]	1	**2.5** Semester	1	**2.6** Type of evaluation	E	**2.7** Type of discipline	DCA

3. Total estimated time (hours / semester of didactic activities)

3.1 No. of hrs. / week	3.5 , of which:	**3.2** course	2	**3.3** seminar/laboratory/ project/training	1.5
3.4 Total no. of hrs. in the education curricula	49 , of which:	**3.5** course	28	**3.6** applied activities	21
3.7 Distribution of time for individual activities related to the discipline					hrs.
Study using a manual, course materials, bibliography and lecture notes					15
Additional documentation in the library, on specialized electronic platforms and on the field					15
Preparation for seminars / laboratories, homeworks, assignments, portfolios, and essays					20
Tutoring					
Examinations					60
Other activities					
Total hrs. of individual activities					110

3.8 Total hrs. / semester[7]	159
3.9 No. of credits	8

4. Prerequisites (where applicable)

4.1 Curriculum	• Physics, Mathematic analysis, Fluid mechanics and hydraulic machines 1, Fluid mechanics and hydraulic machines 2, Numerical simulation in hydraulic machines and equipment, Complements of hydraulic and numerical simulation
4.2 Competencies	•

5. Conditions (where applicable)

5.1 of the course	•
5.2 to conduct practical activities	•

6. Specific competencies acquired

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[1] The form corresponds to the Syllabus promoted by OMECTS 5703/18.12.2011 (Annex3).
[2] The name of the faculty which manages the educational curriculum to which the discipline belongs.
[3] The name of the department entrusted with the discipline, and to which the course coordinator / holder belongs.
[4] Fill in the code provided in GD no. 493/17.07.2013.
[5] The applied activities refer to: seminar (S) / laboratory (L) / project (P) / practice/training (Pr).
[6] The year of study to which the discipline is provided in the curriculum.
[7] It is obtained by summing up the number of hrs. from 3.4 and 3.7.

Professional competencies[8]	• Numerical simulation of the flow hydrodynamics in hydraulic machines and systems • Cavitation and energy optimization of the operation of hydraulic machines and systems
Transversal competencies	•

7. Objectives of the discipline (based on the grid of specific competencies acquired)

7.1 General objective of the discipline	• The lecture presents modern techniques for numerical simulation of the fluid flow in hydraulic machines and equipment with the software FLUENT. There are presented considerations regarding the choosing of the domain for numerical simulations and the discretization with finite elements using the software GAMBIT. For performing the numerical simulation there are presented considerations regarding how to chose the mathematical model, the fluid properties, how to set the boundary conditions and techniques for obtaining the numerical solution with the help of the software FLUENT. A special attention is given to the analysis of the hydrodynamic filed associated to the flow and also to how to evaluate the main characteristics of the flow.
7.2 Specific objectives	•

8. Content

8.1 Course	No. of hours	Teaching methods
Equations of the fluid flow and numerical techniques for solving them. Equations of the flow for the ideal and real fluid. Problem formulation with boundary conditions. Modelling turbulent flows. The principles of the finite volume method.	4	Teaching, conversation, explanations, demonstrations
Choice, description and discretization of the geometry of the numerical simulation domain. Elements of computational geometry. The stages of the description of the geometry for the flow domain. Importing the geometry from CAD software. Discretization of the boundaries, surfaces and volumes. Specification of the information concerning the boundaries and the fluid/solid domain. Exporting the mesh.	6	Teaching, conversation, explanations, demonstrations
The flow of the ideal liquid. Importing the mesh in the numerical simulation software and acaling of the domain. Choice of the mathematical model, 2D (plain/axisymmetric)/3D, steady/unsteady flow. Specifying the density of fluid, imposing the velocity and pressure condition on the boundaries. Numerical solving of the flow problems. Analysis of the hydrodynamic field, plotting the stream lines 2D or 3D, plotting surfaces of equal pressure or velocity. Calculation of the integrated values of the specific flow features.	8	Teaching, conversation, explanations, demonstrations
The flow of the real liquid. Laminar and turbulent flows. Turbulence models available in commercial software. Specifying the dynamic viscosity of the liquid. Solving laminar and turbulent flows. Determining of the hydraulic losses and the detachment and recirculation zones.	6	Teaching, conversation, explanations, demonstrations

[8] The professional competencies and the transversal competencies will be treated according to the Methodology of OMECTS 5703/18.12.2011. The competencies listed in the National Register of Qualifications in Higher Education [Registrul Naţional al Calificărilor din Învăţământul Superior RNCIS] (http://www.rncis.ro/portal/page?_pageid=117,70218&_dad=portal&_schema=PORTAL) will be used for the field of study from 1.4 and the program of study from 1.6 of this form, involving the discipline.

Special problems of liquid flows (heat transfer and fluid flows, free surface flows)	4	Teaching, conversation, explanations, demonstrations

Bibliography[9] 1. R. Susan-Resiga, Mecanica Fluidelor Numerica, Editura Orizonturi Universitare, Timisoara, 2003, ISBN 9736380149.
2. R. Susan-Resiga, S. Muntean, S. Bernad, D. Balint, I. Balint, Metode Moderne de Calcul Paralel pentru Simularea Curgerii Fluidelor, Editura Orizonturi Universitare, Timisoara, 2003, ISBN 9732709588.
3. A. Lungu, Modelari Numerice in Hidrodinamica. Grile de Discretizare, Editura Tehnica, Bucuresti, 2000, ISBN 9733114154. 4. J.H. Ferziger, Peric M., Computational Methods for Fluid Dynamics, Springer, Berlin, 1996, ISBN 3450594345.
5. G. Iaccarino, Computational Methods in Fluid Dynamics using Commercial CFD Codes, Stanford University, ME469B, http://www.stanford.edu/class/me469b.
6. S. Danaila, C. Berbente, Metode Numerice in Dinamica Fluidelor, Editura Academiei Romane, Bucuresti, 2003, ISBN 9732709588.
7. D. Broboana, T. Muntean, C. Balan, Mecanica Fluidelor cu FLUENT, Politehnica Press, Bucuresti, 2005, ISBN 9737838068.

8.2 Applied activities[10]	No. of hours	Teaching methods
1. Using the software GAMBIT 2. Building the domain for numerical simulation. Importing the geometry from CAD software 3. Discretization of the edges, surfaces and volumes from the domain. Analyzing the quality of the mesh. 4. Setting the boundary conditions and on the domain, exporting the mesh. 5. Using the software FLUENT for numerical simulation of the flow. 6. Importing the mesh. Scaling the mesh, visualization and checking of the mesh. 7. Setting the numerical model, fluid properties and boundary conditions fro pressure and velocity	10.5	Explanations, practical examples, data calculation and interpretation
8. Solving inviscid flow and analyzing the hydrodynamics of the flow. 9. Solving viscous laminar flow and analyzing the hydrodynamics of the flow. 10. Solving viscous turbulent flow and analyzing the hydrodynamics of the flow. 11. Calculating the integral values of the flow characteristics (mass flow rate, volumetric flow rate, hydrodynamic forces, hydraulic losses, identifying the detachment zones of the flow). 12. Practical solutions for the enhancement of the energy and cavitation behaviour.	10.5	Explanations, practical examples, data calculation and interpretation

[9] At least one title must belong to the department staff teaching the discipline, and at least 3 titles must refer to national and international works relevant for the discipline, and which can be found in the Politehnica University Library.
[10] The types of applied activities are those specified in footnote 5. If the discipline contains several types of applied activities, then these will be written consecutively in the lines of the table below. The type of activity will be written in a distinct line, as „Seminar:”, „Laboratory:”, „Project:” and/or „Practice/Training:”.

Bibliography [11] 1. R. Susan-Resiga, Mecanica Fluidelor Numerica, Editura Orizonturi Universitare, Timisoara, 2003, ISBN 9736380149.
2. R. Susan-Resiga, S. Muntean, S. Bernad, D. Balint, I. Balint, Metode Moderne de Calcul Paralel pentru Simularea Curgerii Fluidelor, Editura Orizonturi Universitare, Timisoara, 2003, ISBN 9732709588.
3. A. Lungu, Modelari Numerice in Hidrodinamica. Grile de Discretizare, Editura Tehnica, Bucuresti, 2000, ISBN 9733114154. 4. J.H. Ferziger, Peric M., Computational Methods for Fluid Dynamics, Springer, Berlin, 1996, ISBN 3450594345.
5. G. Iaccarino, Computational Methods in Fluid Dynamics using Commercial CFD Codes, Stanford University, ME469B, http://www.stanford.edu/class/me469b.
6. S. Danaila, C. Berbente, Metode Numerice in Dinamica Fluidelor, Editura Academiei Romane, Bucuresti, 2003, ISBN 9732709588.
7. D. Broboana, T. Muntean, C. Balan, Mecanica Fluidelor cu FLUENT, Politehnica Press, Bucuresti, 2005, ISBN 9737838068

9. Corroboration of the content of the discipline with the expectations of the main representatives of the epistemic community, professional associations and employers in the field afferent to the program

- Technical knowledge provided by this discipline allows the students to perform numerical simulation of the fluid flows and heat transfer and the analysis and interpretation of the results. The curricula of this discipline is similar with others from the following universities:
- Ecole Polytechnique Federale de Lausanne, Elvetia, http://sgm.epfl.ch/enseignement/cours /livret_bachelor_2006.html
- Stanford University, S.U.A., http://www.stanford.edu/class/me469b
- Universität Karlsruhe, Germania, http://www.rz.uni-karlsruhe.de/~hf65/KVV/eng-numstroe.htm

10. Evaluation

Type of activity	**10.1** Evaluation criteria	**10.2** Evaluation methods	**10.3** Share of the final grade
10.4 Course	Grade	Solving practical exercises	66%
10.5 Applied activities	**S:**		
	L: Grade	Solving practical exercises	33%
	P:		
	Pr:		
10.6 Minimum performance standard (minimum amount of knowledge necessary to pass the discipline and the way in which this knowledge is verified)			
• The ability to build the numerical analysis domain and the mesh for it and to perform basic numerical simulation set-up			

Date of completion	Course coordinator (signature)	Coordinator of applied activities (signature)
	………………………………	………………………………
Head of Department (signature)	**Date of approval in the Faculty Council[12]**	**Dean (signature)**
………………………………		………………………………

[11] At least one title must belong to the staff teaching the discipline.
[12] Avizarea este precedată de discutarea punctului de vedere al board-ului de care aparţine programul de studiu cu privire la fişa disciplinei.