1. Subject name	**Computational fluid- and thermodynamics**				
2. Subject name in Hungarian	Hő- és áramlástani számítások				
3. Code	**BMEKOVRM606**	4. Evaluation type	**exam grade**	5. Credits	**4**
6. Weekly contact hours	**2 (10) Lecture**	**0 (0) Practice**	**2 (11) Lab**		
7. Curriculum	**Vehicle Engineering MSc (J)**	8. Role	**Mandatory (mc) at Vehicle Engineering MSc (J)**		
9. Working hours for fulfilling the requirements of the subject					**120**
Contact hours	56	Preparation for seminars	18	Homework	20
Reading written materials	10	Midterm preparation	6	Exam preparation	10
10. Department	**Department of Aeronautics and Naval Architectures**				
11. Responsible lecturer	Dr. Veress Árpád				
12. Lecturers	Dr. Veress Árpád				
13. Prerequisites					

14. Description of lectures

Introduction to CFD via industrial applications, Approaches for modelling and conditions for applications, Flow modelling by means of continuum mechanics, System of Navier-Stokes equations, The subject of the CFD; actuality, advantages and application areas, Turbulence and simulation techniques for handling turbulence (DNS, LES and RANS), Reynolds and Favre averaged system of Navier-Stokes equations, Reynolds stress and Eddy viscosity models, Turbulence modelling, k-omega and SST turbulence modelling, Modelling approaches close to the wall; logarithmic-based Wall function and Near-wall resolving approach, Placement of the first cell at the wall, Turbulence boundary conditions at the inlet, Description and characteristics of the most widespread turbulence models, Introduction to discretisation techniques (Finite Difference, Finite Element and Finite Volume Methods), Finite volume method for solving governing equations, The main steps of a CFD simulation tasks; geometry model preparation and simplification, meshing and mesh metrics, material properties, boundary conditions and their definitions, convergence characteristics, visualisation and presentation of the results in qualitative and in quantitative manner, Completing tutor-guided simulation tasks in ANSYS CFX environment with especial care for heat transfer, compressible and incompressible flow and for supersonic flow.

15. Description of practices

16. Description of labortory practices

The students can get experiences in the practical computational steps of the studied CFD methodology by participating in laboratory practices. The following guided simulation tasks are performed during the exercises for example: Flow modelling around a wing profile, CFD analysis of a centrifugal compressor, Numerical flow simulation of particle separation, Free surface flow modelling, CFD analysis of processes developed in combustion chamber, Simulation of turbine stage.

17. Learning outcomes

A. Knowledge
- The student knows the advantages, conditions, application ranges and the theoretical and practical aspects of the most widespread CFD (Computational Fluid Dynamics) methodologies.

B. Skills
- The student can solve CFD simulation tasks independently with especial care for the highest level approximation of the reality and/or at the best “computational cost/accuracy” ratio with verification, plausibility check and validation (in case of interest).
- The student can recognise the fluid and heat transfer phenomena to be improved for increasing the effectivity, can perform the necessary modifications and can check the results of the developments.

C. Attitudes
- The student aims to complete his/her studies at the highest level, under the shortest time, by providing his/her knowledge and capacity at the best to obtain knowledge for deep and independent professional work.
- The student cooperates with professors and mates during the studies.

- The student continuously increases his/her knowledge independently by having information from the external literature to complete his/her studies given by the lectures.

D. Autonomy and Responsibility

- The student takes responsibility for guiding mates by the quality of his/her work and by keeping ethic norms.
- The student takes responsibility for applying the knowledge in line with the studied conditions, limitations and constraints.
- The student can friendly accept the well-established constructive criticism and can utilize that in future.
- The student can accept the form of the cooperation; he/she can work alone or in a team member depends on the actual situation.

18. Requirements, way to determine a grade (obtain a signature)

Different CFD simulation task (homework) – specified by the lecturer – should be completed by each student via weekly consultations and a project report should be prepared according to the given specifications and format. There will be a midterm exam during the semester about the material given by the lecturer till that time. The midterm exam can be repeated once during the semester in case of absence or having grade unsatisfactory. The homework must be completed till the end of the semester and a grade will be given for that also. The students will get semester grade and so signature for their semester performance as mathematical average of the grade given by the midterm exam and homework in case of these grades are not available or unsatisfactory. The semester work is accepted and the signature is given only in case of the semester grade is exist and is not unsatisfactory. The subject is finished by exam about the full material given by the lecturer. The final grade is the mathematical average of the semester grade and the grade given for the exam if these are exists and these are not unsatisfactory. If one of these results are not exist or unsatisfactory the final grade is unsatisfactory.

19. Opportunity for repeat/retake and delayed completion

The midterm exam can be repeated once in a semester in case of absence or unsatisfactory results. There is an extra option to complete the midterm exam in the supplementary week (the week followed by the semester directly) in case of absence or unsatisfactory results besides paying the administration fee. The delivery date of the homework is the last week of the semester. If it is not delivered in time, it is also possible to deliver the homework in the supplementary week besides paying the administration fee.

20. Learning materials

The presentation about the lectures, simulation guide lines and tutorials provided by the professor.
John D. Anderson, JR.: Computational Fluid Dynamics, New York, ISBN-10: 0071132104, ISBN-13: 978-0071132107, McGraw-Hill Higher Education; International edition (1995),
Hirsch, Charles: Numerical Computation of Internal and External Flows, Volume 1 and 2, ISBN-10: 0471923850, ISBN-13: 978-0471923855, John Wiley and Sons (2001),
Veress, Á. and Rohács, J.: Application of Finite Volume Method in Fluid Dynamics and Inverse Design Based Optimization, DOI: - 5772/38786, ISBN 978-953-51-0445-2 (2012) http://www.intechopen.com/books/finite-volume-method-powerful-means-of-engineering-design/application-of-finite-volume-method-influid-dynamics-and-inverse-design-based-optimization
ANSYS, Inc., ANSYS CFX-Solver Theory Guide, Release - 2, ANSYS, Inc. Southpointe, 275 Technology Derive Canonsburg, PA15317, ansysinfo@ansys.com, http://www.ansys.com, USA, 2012

Effective date	10 October 2019	**This Subject Datasheet is valid for**	Inactive courses