Tárgytematika / Course Description
Development of Internal Combustion Engines

AJNM_BMTA036

Tárgyfelelős neve / Teacher's name: Takács Richárd
Félév / Semester: 2026/27/1
Beszámolási forma / Assesment: Vizsga
Tárgy heti óraszáma / Teaching hours(week): 2/0/2
Tárgy féléves óraszáma / Teaching hours(sem.): 0/0/0

OKTATÁS CÉLJA / AIM OF THE COURSE

Aim:

The course aims to give students an overview of the design process of internal combustion engines. In addition to the discussion of recent trends and current design philosophy, students will get a hands-on experience of computer aided design through tutor-lead workshops and an individually chosen project assignment.

TANTÁRGY TARTALMA / DESCRIPTION

Content:

The first lesson will cover the current development trends in internal combustion engines, the challenges and opportunities for development, and how to meet the requirements of quality assurance, customers and various environmental standards.

Topics of the following weeks:

- the purpose, potential and wide range of applications of mechanical simulations. Using the example of a connecting rod used in internal combustion engines, we will observe the construction of simulations based on the finite element method, including the determination of loads, the creation of contacts and other relations, as well as the steps and aspects of the evaluation of the results. In addition to the simulations, the function, mounting and design options of the connecting rods are of course presented, as well as the determination of material quality, surface quality and service life.
- the importance and potential of using flow simulations in internal combustion engines is illustrated using the example of a simplified cylinder wall and its surrounding cooling water space. The architecture, criteria and evaluation of CFD simulations used in industry will be presented.
- AVL Excite Designer software for the vibration analysis of crank mechanism. After a short introduction to the software, you will learn how to use it in practice. The simulation will be structured to give an idea of the mounting and connection points of the crank mechanism and the importance of the geometry of

the components. By evaluating the results, we will be able to obtain various vibration information that will play a key role in the development and design phase of this group of components.
- Other topics taken from current developments (inverters, fuel cells, etc.)

SZÁMONKÉRÉSI ÉS ÉRTÉKELÉSI RENDSZERE / ASSESMENT'S METHOD

Assessment:

In order to complete the course, students have to meet the following premises next to the active and compulsory participation. Each student has to choose and elaborate **2 projects** based on the three presented areas of computer aided development:

- Computational fluid dynamics analysis of a simplified cooling water jacket, or
- Finite element strength analysis of a connecting rod, or
- Vibration analysis of a crank mechanism

The task involves solving the problem under distinct load cases. The projects can only be considered completed if the analysis can be performed and produces results in all cases. The student should interpret the results and explain the differences between load cases in the project report.

Two written project reports have to be submitted. The completed homeworks should be uploaded to the course website of the course SZElearning. Deadline: 04.12.2026. 23:59. The project report must contain the following:

- An introduction to the problem, description of the part to be analysed, structure / workflow of the analysis procedure, parameters and boundary conditions for the analysis,
- Presentation and interpretation of the results,
- Comparison of results from different load cases,
- Summary of the project work, including the applicability of the results.

The general structure, style and formatting of the project report must comply with the following criteria:

- A clear, impartial formulation should be used, with appropriate technical terms,
- A clean and stylish graphical representation of models, results and the workflow itself is preferable, which shows the necessary information without overwhelming the reader,
- The report should give a detailed description of the analysis process, making it possible for third parties to reproduce the results,
- The report should be submitted in MS Word .docx format, and therefore must utilize the built-in formatting and styling capabilities of the software.

Unformatted texts and unstructured reports will be rejected without further explanation.

The project work will be graded based on the technical content, formulation and formatting of the submitted project reports at the end of the semester.

KÖTELEZŐ IRODALOM / OBLIGATORY MATERIAL

Literature:

- Richard Stone, Introduction to Internal Combustion Engines, 2.ed., Palgrave Macmillan, 1992, ISBN 978-0-333-55084-7, DOI 10.1007/978-1-349-22147-9
- Richard Van Basshuysen, Fred Schaefer, Internal Combustion Engine Handbook, 2.ed., SAE International, 2016, ISBN 978-0-7680-8024-7
- Amar Khennane, Introduction to Finite Element Analysis Using MATLAB® and Abaqus, 1.ed., CRC Press, 2013, ISBN 9781466580206
- Joel H. Ferziger , Milovan Peric, Computational Methods for Fluid Dynamics, 3.ed., Springer-Verlag Berlin Heidelberg, 2002, ISBN 978-3-540-42074-3, DOI 10.1007/978-3-642-56026-2
- John F. Wendt, Computational Fluid Dynamics - An Introduction, 3.ed., Springer-Verlag Berlin Heidelberg, 2009, ISBN 978-3-540-85055-7, DOI 10.1007/978-3-540-85056-4

AJÁNLOTT IRODALOM / RECOMMENDED MATERIAL