Subject Guide – Computer-Aided Engineering Tools 2

Shortened Name	CAET2	**Semester**	2-2023
Class Time (weekly)	Thu, 13-16 hrs	**Lecture hours**	3h x 15w
Subject Code	090125209	**Assignment and self-study**	5h x 15w
ECTS credits	6	**Preparation for exam**	30
KMUTNB Credits	3(3-0-6)	**Total working hours/semester**	150

1 Revision date of this document, reasons for revision

- 02.01.2024

2 Course description

A series of self-contained modules to give students the necessary knowledge and practical skills needed for the application of computers and engineering software on engineering problems, specifically in the fields of

- Computational Fluid Dynamics (CFD),
- Advanced CAD techniques for Freeform-Surface Design and Reverse Engineering and
- Advanced FEM for Structural Design and Analysis (surface contacts, topology optimization, modal analysis).

The class enables the students to apply the covered tools in other courses as well as research and thesis work and prepares industrial application. At least an introductory standard is established that enables the students to continue to develop their skills by further self-study or self-guided tutorials. The covered software includes commercial and non-commercial products and is constantly revised to keep up with current developments and to balance the requirements of industrial application and academic research.

3 Lecturers & Teaching Assistants

- CAD (PTC Creo Parametric): Dr.-Ing. Alex Brezing (class coordinator)
- FEM (ANSYS): Dr.-Ing. Alex Brezing, Nattawood Prasartthong, Suparoj Premjarunan
- CFD (ANSYS): Dr. Ekachai Juntasaro, Nattawood Prasartthong

4 Expected learning outcomes (in accordance with the MAE program ELOs)

Primary LOs (primary content of class, knowledge is explicitly evaluated (for example, by exams), larger share of overall grade):

- Knowledge and understanding of principles, techniques and the methodology of:
  - the design and reverse-engineering of complex geometries,
  - the simulation of a wide range of phenomena in the field of fluid dynamics,
  - the design of structural components by topology optimization approaches as well as structural simulations which are integrated into virtual product development (3D-CAD and modelling), (SELO 1).
- Ability to transform an actual technical scenario into a valid model that can be used for a simulation or design (SELO 4)
- Ability to use commercial software to simulate the bahavior of solid bodies and fluids relevant for engineering applications (SELO 5)
- Ability to apply methodology and commercial CAD software to design complex geometries (free-form surfaces) and structural components (SELO 6)

Secondary LOs (not primary content of class, but implicitly taught by application, for example by project work or assignments, lower share of overall grade)

- Ability to enhance and deepen one's knowledge and skills in the above-mentioned computer-aided applications without specific instructions or pre-selected materials. (GELO 8)
- Knowledge of engineering materials and modes of failure (SELO 7)
- Knowledge and understanding of scientific fundamentals relevant for the understanding of the behavior of solid bodies, structural components and fluids in engineering applications (SELO 2)

Notes on ELOs:

- These ELOs correspond to the Program ELOs (referenced in parentheses) but are specifically worded for this course by omissions and additions.

5 Assessment

Each student will be individually assessed based on the performance on assignments and a written exam, with the overall grade resulting from the shares as below:

	Assignments	**Exam**
Computational Fluid Dynamics (CFD)	35%	108/180 points
Advanced CAD	15%	36/180 points
Advanced Structural FEM	20%	36/180 points
Total share	**70%**	**30%**

- Assignments will be given as homework during most classes (see below). All assignments are due at the beginning of the next class, submitted by email to the lecturer who held the class. Late submission results in 20% deduction per week.

- Comprehensive exam, closed book, mostly written/paper-based; CAD-part possibly partly done on students' own laptop. 180 minutes.

6 Teaching materials

- Lecture slides and assignments are shared as electronic files.

7 Books and references

- ANSYS FLUENT User's Guide Release 2022 R2
- ANSYS FLUENT Tutorial Guide Release 2022 R2
- ANSYS FLUENT Manual Release 2022 R2

8 Course schedule

Week	Date (2024)	Activity, Class Title (unit number)	Evalu-ation %	Class Hours
1	04/01	CAD/creo: Introduction to Surface Modelling (1), Assignment	5%	3
2	11/01	CAD/creo: Freeform Surface Modelling (2), Assignment	5%	3
3	18/01	CAD/creo: 3D Geometry Scanning (Demo) (3)		3
4	25/01	CAD/creo: Reverse Geometry Modelling (4), Assignment	5%	3
5	01/02	FEM/ANSYS: Modal Analysis (5), Assignment	5%	3
6	08/02	FEM/ANSYS: Assembly/ Contact Modelling A (6), Assignment	5%	3
7	No class (Prof. Schindler's RVVD Block Lecture)			
8	22/02	FEM/ANSYS: Assembly/ Contact Modelling B (7), Assignment	5%	3
9	29/02	FEM/ANSYS: Topology Optimization (8), Assignment (Normal class in MIDTERM WEEK)	5%	3
10	07/03	CFD/ANSYS: Introduction to CFD/ANSYS (9)		3
11	14/03	CFD/ANSYS: Geometry Preparation for CFD (10), Assignment	5%	3
12	21/03	CFD/ANSYS: Meshing for CFD (11), Assignment	10%	3
13	28/03	CFD/ANSYS: Laminar Pipe Flow Simulation (12), Assignment	5%	3
14	04/04	CFD/ANSYS: Turbulent Pipe Flow Simulation (13), Assignment	5%	3
15	11/04	CFD/ANSYS: Transient Flow Simulation (14), Assignment	5%	3
16	18/04	CFD/ANSYS: Heat & Fluid Flow Simulation (15), Assignment	5%	3
17	25/04	No class / Buffer week		
18	02/05	Final (paper-based) exam	30%	
19	09/05	Buffer week		
			100%	45

9 Content details

Unit #	Title	Lesson (L) Contents
1	CAD/creo: Introduction to Surface Modelling	• Surface modelling: introduction of workflow and functions • Surface-modelling of geometry with parametric geometry • Demonstration and assignment: motorcycle helmet
2	CAD/creo: Freeform Surface Modelling	• Freeform surface modelling: workflows and techniques • Modelling of vehicle bodies with boundary blends • Demonstration and assignment: i-Pad housing
3	CAD/creo: 3D Geometry Scanning (Demo)	• Visit of STRI-labs and demonstration of freeform-scanning • Optical scanning: technology and workflow • Tactile scanning: technology and workflow
4	CAD/creo: Reverse Geometry Modelling	• Reverse-Engineering of complex geometries with scans • RE methodology, analysis of design-intent, workflows • CAD-RE-techniques: reverse modelling, datums etc.
5	FEM/ANSYS: Modal Analysis	• Modal Analysis: fundamentals and application examples • Demonstration of simulation worklflow with ANSYS • Assignment: design of pitch-fork with given frequency
6	FEM/ANSYS: Assembly/ Contact Modelling A	• Simplified simulations of assemblies for design validation • Techniques: geometry import, meshing, simple contacts • Assignment: design optimization of a structural assembly
7	FEM/ANSYS: Assembly/ Contact Modelling B	• Large deformations and complex contact problems • Introduction to structural nonlinearity, example-simulation • Assignment: Thin tongue bending against support
8	FEM/ANSYS: Topology Optimization	• Introduction to Topology Optimiztaion (TO) • Demonstration of the TO-workflow in ANSYS • Assignment: TO-application on a rickshaw frame
9	CFD/ANSYS: Introduction to ANSYS FLUENT	• CFD/ANSYS: Overview • ANSYS FLUENT: Software installation • ANSYS FLUENT: Introduction
10	CFD/ANSYS: Geometry Preparation for CFD	• ANSYS DISCOVERY: Creating geometry • Preparing control volumes for CFD analysis • Demonstration and assignment: Blower machine
11	CFD/ANSYS: Meshing for CFD	• ANSYS MESHING: Introduction to ANSYS MESHING • Demo: 2D conical combustion chamber and 3D manifold • Assignment: Mixing tank and 2D airfoil
12	CFD/ANSYS: Laminar Pipe Flow Simulation	• ANSYS FLUENT: Setting up laminar flow • Pre- and Post-processing: Workflows and techniques • Demonstration and assignment: Pipe flow
13	CFD/ANSYS: Turbulent Pipe Flow Simulation	• ANSYS FLUENT: Setting up turbulent flow • Pre- and Post-processing: Workflows and techniques • D/A: Turbulent pipe flow
14	CFD/ANSYS: Transient Flow Simulation	• ANSYS FLUENT: Setting up transient flow • Pre- and Post-processing: Workflows and techniques • D/A: Vortex shedding of a cylindrical rod
15	CFD/ANSYS: Heat & Fluid Flow Simulation	• ANSYS FLUENT: Setting up heat transfer • Pre- and Post-processing: Workflows and techniques • D/A: Flow across tube banks

D/A: demonstration and assignment

10 Details on the evaluation of Expected Learning Outcomes

		Assignments	MT-Exam	
		70%	30%	
SELO1	Knowledge and understanding of principles, techniques and the methodology of • the design and reverse-engineering of complex geometries, • the simulation of a wide range of phenomena in the field of fluid dynamics, • the design of structural components by topology optimization approaches as well as structural simulations which are integrated into virtual product development (3D-CAD and modelling)	7.0%	3.0%	**10%**
SELO4	Ability to transform an actual technical scenario into a valid model that can be used for a simulation or design	7.0%	3.0%	**10%**
SELO5	Ability to use commercial software to simulate the bahavior of solid bodies and fluids relevant for engineering applications	25.0%	10.0%	**35%**
SELO6	Ability to apply methodology and commercial CAD software to design complex geometries (free-form surfaces) and structural components	8.0%	7.0%	**15%**
GELO8	Ability to enhance and deepen one's knowledge and skills in the above-mentioned computer-aided applications without specific instructions or pre-selected materials	14.0%		**14%**
SELO7	Knowledge of engineering materials and modes of failure	4.0%	2.0%	**6%**
SELO2	Knowledge and understanding of scientific fundamentals relevant for the understanding of the behavior of solid bodies, structural components and fluids in engineering applications	5.0%	5.0%	**10%**