Computational Fluid Dynamics for Engineers KKR073 -2020

Welcome to the CFD course! We believe you will learn a lot from the course and have a lot of fun by working in small teams (2 persons) in tutorials and in the design project.

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Lectures (Mondays and Wednesdays) in different lecture halls e.g. HA2, EC, see TimeEdit.

Monday	23/3	8-10	Course introduction (chapter 1+2)
Monday	23/3	10-12	Numerical methods (chapter 3)
Wednesday	25/3	10-12	Turbulence modelling (chapter 4)
Monday	30/3	8-10	Turbulence modelling (chapter 4)
Monday	30/3	10-12	Mixing (chapter 5)
Wednesday	1/4	10-12	Mixing (chapter 5)
Friday	3/4	13-15	Multiphase flow (chapter 6)
Wednesday	15/4	10-12	Multiphase flow (chapter 6)
Monday	20/4	8-10	Multiphase flow (chapter 6)
Monday	20/4	10-12	Best Practice (chapter7) + Invited lecture from industry #1 TBC
Wednesday	22/4	10-12	Old exams + Invited lecture from industry #2 TBC
Thursday	23/4	16-18	Consultation/Seminar, TBD room to be announced
Wednesday	29/4	10-12	Consultation/Seminar, TBD room to be announced
Saturday	2/5	8.30-12.30	Written examination. Examiner makes the registration for all students.
Monday	4/5	8-12	Spare time
Wednesday	6/5	13.15-14	Invited lecturer from industry #3
Wednesday	20/5	18.00	Deadline project report
Mon-Wed	25-27/5		Project presentations (1hour sessions), see information on next page.
Monday	1/6	14.00-18	Second chance to write the exam

Tutorials

Tutorial 1 starts Wednesday 25/3 report deadline 3/4.
Tutorial 2 starts Wednesday 1/4 report deadline 16/4.
Tutorial 3 starts Wednesday 15/4 no report required for Tutorial 3.

Computer rooms on Wednesdays 13-17, Thursdays 13-17. Additional computer time is available on Mondays after the lecture series is finished in beginning of May. Computer rooms vary between KD1, KD2, KB-D41, see TimeEdit. Tutorial reports are handed in via Canvas. No report is required for tutorial 3. You will work in groups of two during the tutorials and the project, discussions between groups in the class is encouraged. Tutorial grading is passed or failed.

NOTE regarding computer sessions on Thursdays.
Thursday afternoon sessions are outside the block (intended) and not compulsory to attend. This normally works well, since we never introduce new material on Thursdays (you only finish what you started earlier). If you miss this session you can finish the remaining work at another time. The software can also be installed on your private computer (typically done by 80% of the students).

Software

You may download and use free student version of Ansys software. This contains all physics but is limited to half million cells which is enough for this course. We give no installation support but on the other hand there has been no problem installing the software. We strongly recommend you use the same software version as in Chalmers computer room to avoid problems. We use Ansys v18.0 in computer rooms, which can be downloaded from this link:
https://drive.google.com/file/d/1QyTrtkQ0BSmch1nDiJqHkWRG7nACo3Q1/view?usp=sharing

Project presentation and report (3.5 ECTS)

You will be given an open ended design project, you don't need to find one on your own.
We use a peer-review system, another group in the class will read your report and prepare questions they will ask when you are presenting your project. For this to work we need to keep to the schedule:

Project start	22/4 at 13:15
Deadline written report	20/5 at 18:00
Oral presentation	Monday 25/5 10.00-15.00
Oral presentation	Tuesday 26/5 8.00-11.45
Oral presentation	Wednesday 27/5 13.15-17.00

Each group need to be present during 1 hour for oral presentation. Every hour 3 groups (20 min each) present their results, see detailed instructions below. There will be plenty of time slots available for you too book.

Instructions for project presentations

The main purpose with the oral presentations is to evaluate how you manage to present the CFD analysis you have done, the conclusions and recommendations you can make, and your ability to identify and reflect on weak points in the analysis.

1.) Each group prepare 8 minutes presentation. If you exceed 10 minutes you will be interrupted due to our time constraint. You should not give an extensive background to 'ammonia-SCR' or 'CFD in general' as everyone in the course is aware of the task, keep this part very brief. It is recommended you discuss quality aspects in problem formulation, choice of models, boundary conditions, mesh independence, how do you interpreter your results, what phenomena you observe and what conclusions could you draw. Conclude how to make a good SCR design.
2.) Each group have the responsibility to read and prepare questions on a report from another group in the class (peer-review). You instructor will assign the report to you. Please prepare about 5 questions for the CFD report you read. Total time for the questions/answer session is 8 minutes per group. 2 minutes remain for the instructors and examiner to ask questions and load next presentation.

Instructions for project report

A good project report means you reflect on how the CFD model is formulated, quality of mesh, numerical methods, selection of boundary conditions, physical models and their limitations; it also means you show you have been able to analyze convergence, mesh independence and interpret the results following best practice(among others, this is not intended as a checklist). The last chapter in the book (Chap 7) contains a summary of best practice for CFD analysis.

1.) It is important to relate your problem formulation with theory, however you should not write a CFD book. Remember the project report should focus on *problem formulation, solution and analysis, and the conclusions* you can make.
2.) The CFD project report must include a contribution report (a few sentences) that clarify who did what and indicate how the overall workload was shared. Ideally the contribution is 50-50, 60-40 is also OK, but obviously 90-10 is not acceptable.
3.) Your report should only contains figures that you discuss in the text. When it is appropriate, try to condense data from many CFD simulations and present these in tables or graphs to save space the report. Try to keep the report 20-25 pages, quality bets quantity.
4.) All project reports are uploaded to Canvas for plagiarism analysis in Urkund. The analysis is done automatically as soon you upload your report on Canvas. Urkund can analyze pdf-files, but zipped files cannot be processed.
5.) You receive peer-review feedback from the student group that read you report, from your instructors after the presentation, and possibly also from the examiner for students that do oral examination.

Course literature

Paperback version (sold at Cremona for approximately 250 SEK)
B. Andersson, R. Andersson, L. Håkansson, M. Mortensen, R. Sudiyo, B. van Wachem, Computational Fluid Dynamics for Engineers, Chalmers internal edition.

Hardcover version (sold at Amazon, Bokus, Adlibris, close to 850 SEK)
B. Andersson, R. Andersson, L. Håkansson, M. Mortensen, R. Sudiyo, B. van Wachem, 2011, Computational Fluid Dynamics for Engineers, IBSN 978-1107018952, Cambridge University Press.

Library version (electronic version and one hardcopy)
B. Andersson, R. Andersson, L. Håkansson, M. Mortensen, R. Sudiyo, B. van Wachem, 2011,

Thanks to valuable feedback from previous students the book has been (and will be with you help) continuously improved from one year to the next. Following discussions with MSc and PhD students I would like to take the opportunity to give you a few study advises to be successful and save time.

1. Chapter 2 contains a summary of previous courses e.g. transport phenomena, fluid mechanics or continuum physics courses. You should have a look at this before the course starts and refresh if needed. (You may download the book as ebook from the library before the course starts)
2. You will find the lectures most useful, and minimize your overall study time, when you prepare in advance by reading quickly through each chapter in the textbook, to get acquainted with the concepts and the vocabulary.
3. Try to get to the point where you understand the physics, can read the equations and directly see what physics it represents, and how it is modelled, as early as possible in the course. Since the textbook is rather compressed it can be useful to the read the text a second time.

Continuous improvements

Development and update of FAQs in tutorials, based on feedback from students.

Examination

Written examination (4.0 ECTS). Chapter 5.7-5.12 is not included in the exam. We do an early exam in May as it allows improved project results. This means you don't have any CFD exam to write in June unless you failed or did not attend the May exam. June exam gives a second chance to pass the exam or to obtain higher grade, there is also an exam in August.

Grading

Passed (*Grade 3)*
Passed written examination (15 points = 50% passed), tutorials and project

Higher grades
Grade 4

- Good project report and presentation
- Good written examination (20 points = 2/3 passed)

Grade 5

- Good project report and presentation
- Good written examination (20 points = 2/3 passed)
- Oral examination (45 min). Mostly discussion about two questions related to extension of the project (found on the last page of the project-instruction document), and poor parts in the written examination. Prepare by doing hand-calculations in advance to answer the two question. Book time with examiner, as soon project report is presented and corrected.