Course Information

Class Days/Time: TR 5:55 – 7:10
Classroom: KL 445
Pre-Requisite: MEE 504 Fundamentals of Fluid Mechanics or similar
Instructor: Markus P. Rumpfkeil
Office Location: KL 361 F
Email Address: Markus.Rumpfkeil@udayton.edu
Office Hours: By appointment

Course Web Page

All course materials such as the syllabus, major assignments, and handouts can be found on the course web site located at http://academic.udayton.edu/MarkusRumpfkeil/MEE558.html

Course Description

This course on Computational Fluid Dynamics (CFD) introduces the numerical computation of continuum fluid flows in engineering applications. One focus of the course is on numerical methods for the solution of the nonlinear governing fluid equations. Emphasis will be placed on finite difference and finite volume numerical formulations. Iterative and temporal solution procedures will also be covered. The students will get hands-on experience with these methods by programming simple algorithms (in Matlab, Fortran, C, or C++), investigating the characteristics of the methods and validating them against analytical solutions. The course will also give an introduction to the use of commercial CFD codes (Fluent) to analyze flow problems of practical engineering interest. At the end of the course students will understand the process of developing a geometrical model of the flow, applying appropriate boundary conditions, specifying solution parameters, and visualizing the results. They will also have an appreciation for the factors limiting the accuracy of CFD solutions. In addition, the course will provide a first step into the large and expanding research area of general computational physics and the basis for self study into more complex CFD.

3 semester hours.

Course Topics

1. Introduction
2. Conservation Laws
3. Finite-Difference and Finite-Volume Discretizations
4. Solution of Linear Systems
5. Time Marching Methods
6. Turbulence Modeling
7. Numerical Dissipation

Textbook/s


Computational Fluid Dynamics: The Basics with Applications, J. D. Anderson


Computational Fluid Dynamics: A Practical Approach, J. Tu, G. Yeoh, C. Liu
Overall Course Goals or Student Learning Objectives

- Give students a working knowledge of a variety of computational techniques that can be used for solving engineering fluid problems
- Develop student's capability to write computer software
- Develop student's capability to run black-box CFD codes in an informed manner
- Develop student's ability to present CFD results and to visualize data of computational engineering fluid problems

Course Content Learning Outcomes

Upon successful completion of this course, you will be able to:

- Conceptually understand several numerical techniques (Spatial and temporal discretizations, linear solution methods) in terms of accuracy, stability, and convergence
- Program simple potential flow and ODE solvers in Matlab
- Solve basic fluid dynamics problems drawn from engineering applications using commercial computer codes
- Perform grid convergence studies
- Write comprehensive reports about CFD simulations
- Conceptually understand the basics of turbulence modeling
- Self study into more complex CFD methods and problems

Assignments and Grading Policy

Homework Assignments and small projects – 70% of overall mark
Final project – 30% of overall mark

A total of approximately six problem sets, computer assignments, or small projects will be given on a roughly bi-weekly basis. While discussion of the homework and projects is encouraged among students, the work submitted for grading must represent your understanding of the subject matter.

Grading Scale:

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<thead>
<tr>
<th>Grade</th>
<th>A</th>
<th>A-</th>
<th>B+</th>
<th>B</th>
<th>B-</th>
<th>C+</th>
<th>C</th>
<th>C-</th>
<th>D</th>
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<tbody>
<tr>
<td>Minimum Score</td>
<td>93%</td>
<td>90%</td>
<td>87%</td>
<td>83%</td>
<td>80%</td>
<td>77%</td>
<td>73%</td>
<td>70%</td>
<td>60%</td>
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**Classroom Protocol**

All electronic devices including cell phones must be turned off and are not to be visible at any time during class unless specifically directed by the instructor. Notebook computers may be used in class for taking notes and specified in-class activities, not for instant messaging, email or other distractions.

In addition, as a student in this class, you are expected to:

- Take ownership and responsibility for the conduct of the class.
- Always treat class members with respect.
- Be considerate and limit materials or actions that others might find distracting, such as conversations, work from other classes, newspapers, video games, etc.
- Be prepared to contribute to group and class discussions in a courteous, substantive, and thoughtful manner.

**University Policies**

**Academic Honesty**

I encourage you to talk with each other about the ideas brought up in class. But in all assignments to be graded as individual work you are expected to do your own written work. In the case of group work, all members of a group will be held responsible for the content of work turned in to satisfy group assignments. For specific university policies concerning academic honesty, see the University’s [Academic Honor Code](http://bulletin.udayton.edu/content.ud?v=29&p=3286&c=3313) in the Bulletin.

**Dropping the Course**

You are responsible for understanding the university’s policies and procedures regarding withdrawing from courses. You should be aware of the current deadlines and penalties for dropping classes. Information on [withdrawal from courses](http://bulletin.udayton.edu/content.ud?v=29&c=3312&p=3286) is available in the Bulletin under Grades and Scholarship and from your Dean’s Office.

**University Services (free for all students)**

**Support for Your Learning in This Course**

The LTC’s Office of Student Learning Services (SLS) is a learning resource for all students at the University of Dayton. SLS offers a wide variety of services to assist you in achieving academic success at the University, including study skills classes and workshops, tutoring and consultations, disability screenings, and a web site with many resources ([http://learningservices.udayton.edu](http://learningservices.udayton.edu)). Please contact SLS at 937-229-2066 or visit their office on the ground floor of Roesch Library (LTC, room 023) if you would like to talk about how you could become a more effective learner.

**Students with Disabilities**

Your learning in this course is important to me. I invite you to come talk with me about ways to ensure your full participation in the course. If you feel you need an accommodation based on the impact of a disability, please contact me privately to discuss your Self-Identification Form as provided by the LTC’s Office of Student Learning Services (SLS). It is important that you be registered with SLS and notify me of your eligibility for reasonable accommodations in a timely manner, and, when appropriate, that we make special arrangements in case of an emergency building evacuation. For more information about disability services at the University of Dayton, please contact SLS at 937-229-2066, by email at disabilityservices@udayton.edu or stop by SLS in the LTC, room 023.