ME 4340/6340 – Spring 19

Wright State University
Department of Mechanical and Materials Engineering
ME 4340/6340: Simulation of Thermal-Fluids Problems with Advanced Engineering Software

Syllabus
revised 3/12/2019

Time: MW, 4:40 PM – 6 PM; Location: Russ 141

Instructor: Dr. Philippe Sucosky
Office: 257 Russ Engineering Center
Office phone: (937) 775-4650
Email: Philippe.Sucosky@wright.edu

WEEKLY SCHEDULE:

<table>
<thead>
<tr>
<th>Time</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
</tr>
</thead>
<tbody>
<tr>
<td>11 AM – 12 PM</td>
<td>Office hour</td>
<td></td>
<td>Office hour</td>
<td></td>
<td>Office hour</td>
</tr>
<tr>
<td></td>
<td>(257 Russ)</td>
<td></td>
<td>(257 Russ)</td>
<td></td>
<td>(257 Russ)</td>
</tr>
<tr>
<td>4:40 – 6 PM</td>
<td>Lecture</td>
<td></td>
<td>Lecture</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(141 RC)</td>
<td></td>
<td>(141 RC)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

COURSE DESCRIPTION AND OBJECTIVES: This is a first course in computational fluid dynamics (CFD) for mechanical engineering students. The objective is to introduce the key components of CFD analysis and the methods to solve a fluid flow problem using advanced CFD software.

By the end of this course, students will be able to:
- Identify, recognize and define basic concepts in CFD
- Apply those concepts to solve practical problems encountered in mechanical engineering and other engineering disciplines

The topics to be covered are as follows:

1. Introduction to CFD
2. Conservation equations
3. Finite volume method
4. Application to diffusion and convection-diffusion problems
5. Solution algorithms for pressure-velocity coupling
6. Finite volume method for unsteady flows
7. Implementation of boundary conditions
8. Complex geometries
9. Error and uncertainty
10. Turbulence modeling

MATERIALS:
The class will use lecture notes, handouts (completed in class) and the CFD package ANSYS Fluent.

- Reference: Your main references will be the ANSYS User’s Guide manuals that are part of the CFD software installation. In addition, you may wish to refer to general textbooks for Statics, Dynamics, Fluid Mechanics, Fluid Dynamics and Heat Transfer. While the notes provided during the lectures contain sufficient information to help you understand the mathematical and numerical concepts, some additional reading assignments will be suggested for each chapter. These will be extracted from the optional textbook:


- Website: Information about the course will be posted online on my laboratory website: http://www.wright.edu/~philippe.sucosky/ME4340.html.
- **Computing Resources:** Assignments will require the use of a laptop/desktop computer and the commercial CFD package ANSYS Fluent. Laptop computers loaded with ANSYS will be available in the lecture room. The CFD lab in Russ also features workstations with the software suite. ANSYS can be installed in your personal computer upon request.

- **Office Hours:** Three office hours per week. In case of conflict, appointments with the instructor can be requested by email (at least 48 hours in advance).

**Prerequisites:** ME 3360 (Heat Transfer)

**Assessment:** Grading will be based on 1) attendance, 2) completion of weekly assignments, and 3) a semester project.

- **Attendance:** Attendance will be formally checked and will count for 12% of your grade (ME 6340: 6%). The project presentation is mandatory. Students who do not complete the project or do not give the presentation will fail the class.

- **Weekly Assignments:** Weekly homework will consist of 7 tutorials (with reports), 6 project progress reports and special project documents.
  - Homework assignments are due on the Wednesday following the date assigned. The assignments should be prepared according to the format rules described below (see “graded work format”).
  - Tutorial reports: These reports should contain the information requested in each assignment (typically a few figures or calculations described in the tutorial guide). One report per student.
  - Project progress: Each team is required to produce a weekly progress report summarizing the work performed on the project during the current week. The reports should include sufficient details and should discuss challenges and potential solutions. One report per team.
  - Special assignments: Additional assignments will consist of a description of technical interests (1 per student), a description of possible project topics (1 per team) and a description of the selected project topic (1 per team).

- **Semester Project:** Part of the grade for this class is earned by performing a full CFD analysis.
  - Projects are to be performed in teams of three. With permission of the instructor, projects may be performed individually or with larger groups if there is a good reason to do so.
  - The topic of the CFD analysis can be picked by the students based upon their own personal interest or the research they are currently doing, or it can be a problem suggested by the instructor. To avoid excessive calculation times, the problem should be one that can be modeled as a steady state problem in 2D or 3D with less than 200k grid cells, or as an unsteady problem in 2D with less than 10k grid cells.
  - The selection of the semester project will be discussed with the instructor and the topic needs to be agreed upon by Week 7.
  - The final examination consists of a project report and a presentation by each team to the full class and the instructor.
  - The report and presentation should include a description of the flow problem; why it is of interest; the computational grid; the boundary conditions; physical models and numerical schemes used; the flow pattern results accompanied by an interpretation; and any applicable quantitative data extracted.
  - The project presentation is mandatory. Students who do not complete the project or do not give the presentation will have failed the class.
- **Final Score**: The final score will be calculated according to the following grading categories:

<table>
<thead>
<tr>
<th>Grading Category</th>
<th>ME 4340</th>
<th>ME 6340</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attendance</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>HW1: tutorial T1 + technical interests + group selection</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>(tutorial: 4 pts; interests: 2 pts)</td>
<td>(tutorial: 3 pts; interests: 0 pt)</td>
<td></td>
</tr>
<tr>
<td>HW2: tutorials T4 + T6</td>
<td>8 (4 pts × 2 tutorials)</td>
<td>6 (3 pts × 2 tutorials)</td>
</tr>
<tr>
<td>HW3: List of project topics</td>
<td>8 (4 pts × 2 abstracts)</td>
<td></td>
</tr>
<tr>
<td>HW4: tutorials T8 + T10</td>
<td>8 (4 pts × 2 tutorials)</td>
<td>6 (3 pts × 2 tutorials)</td>
</tr>
<tr>
<td>HW5: tutorials T12 + T15</td>
<td>8 (4 pts × 2 tutorials)</td>
<td>6 (3 pts × 2 tutorials)</td>
</tr>
<tr>
<td>HW6: Final project topic description</td>
<td>5 (structured abstract format)</td>
<td>10 (SA page format)</td>
</tr>
<tr>
<td>HW7-10: Electronic files and progress description</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>(5 pts × 4 assignments)</td>
<td>(5 pts × 4 assignments)</td>
<td></td>
</tr>
<tr>
<td>Final report (publication format)</td>
<td>10</td>
<td>20 (paper format)</td>
</tr>
<tr>
<td>Project presentation to class</td>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>

- **Final Grade**: The final grade will be determined according to the following tentative distribution:
  
  A: [85, 100]  
  B: [75, 85]  
  C: [60, 75]  
  D: [50, 60]  
  F: [0, 50]  

  This distribution is provided for information only and might be altered.

**Policies**:

- **Homework and Exam Policies**:
  
  o Cheating will not be tolerated and will be dealt with as severely as policy permits.  
  o Your work is expected to be neat. Unreadable homework will not be graded.

- **Graded Work Format**:
  
  o Work handed in for grading will be prepared according to the following general rules:
    
    ▪ You may submit your homework either as a hard copy or as a pdf.  
    ▪ Use only 1 side of a standard letter size (8.5 x 11 in) paper.  
    ▪ Place the names/UIDs (or both) of the students in your group at the top of each page.  
  
  o Tutorial reports (HW 1, 2, 4, 5):
    
    ▪ 1 report per student  
    ▪ Provide all necessary figures and screenshots to show your work.  
    ▪ Include units. Results without units (if applicable) will be considered wrong.  
    ▪ Specify the equations used by the model.  
    ▪ Clearly state all your assumptions and their justification.  
    ▪ When possible, discuss the appropriateness of your approach based on the material covered in class.
  
  o Progress reports (HW 7-10):
    
    ▪ 1 report per team  
    ▪ 5-page limit
  
  o Description of technical interests (HW 1):
    
    ▪ 1 document per student  
    ▪ description of your technical interests, research projects and objective in taking this class  
    ▪ 1-page limit
- **Grading corrections:** In most situations, grades and scores are considered final, unless an arithmetic error has been made in the score calculation. Any disputes over grading should be brought to the instructor. Submit within one week of receiving the graded item:
  - The original, unaltered homework or exam.
  - A written description of the grading error.
  - What you believe a fair score for the problem should be.

- **Late work and make-up policies:**
  - Homework is due on Wednesdays, at the beginning of the lecture.
  - Late homework will not be accepted.
    - If it is your first late homework, it will not be accounted for in your final homework score.
    - If it is not your first late homework, it will be assigned a score of zero. No excuse or discussion.
  - Make-up assignments or examinations will not be permitted, except in the rarest of circumstances.

- **Honor code:** Students are expected to understand and abide by the principles and procedures set forth in Wright State University’s Code of Conduct (http://www.wright.edu/community-standards-and-student-conduct/code-of-student-conduct).
  - Working together, asking questions of classmates, or assisting others on exams is prohibited. Students are obliged, under the honor code, to report any improprieties during the exam. The instructor or a teaching assistant will be present during exams to answer questions.
  - Students may collaboratively discuss course assignments but are expected to write and complete their own assignments independently.

**Disclaimer:** Additions, amendments, or revisions to the present syllabus may be made throughout the semester via announcements, handouts or emails.

**Questions, contact information:** Questions are welcome during the lectures and during office hours. Should a conflict in schedules prohibit you from coming during the posted office hours, other arrangements can be made. Feel free to send your questions via email (expect a reply within 24 hours during the week).