ME 5305 - Computational Fluid Dynamics
Spring 2011
M,W,F 2:00 – 2:50 (M,W SpHC 210; F Engr 204)

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Office Hours: Mon, Wed, Fri 11:00-12:00, Tues 3:00-4:00 (or by appointment)

Textbook: Required – Tu, Jiyuan, Yeoh, Guan Heng and Liu, Chaoqun, *Computational Fluid Dynamics: A Practical Approach*, Elsevier Inc., (2008).

Course Web Page: We will use Moodle for the course website. To access the course site, go to the My Courses tab at the myU portal: http://myu.umn.edu or use the following link: https://moodle.umn.edu/course/view.php?id=15791 (you will have to log in). Grades will be posted using eGradebook.

Course Catalog Description: (3.0 cr; & ME 4112, BSCHE, BSIE or BSME candidate or #; A-F only) Finite-difference methods for steady and transient diffusion and convection-diffusion problems. Finite-Volume technique for the solution of multi-dimensional fluid flow, and heat and mass transfer problems. Utilize CFD software to solve complex problems.

Prerequisites: & ME 4112, BSCHE, BSIE or BSME candidate or #; A-F only

Course Components: The coursework consists of homework, two exams, and a final proposal. We will have class one day each week (Friday) in a computer lab. The purpose of the computer lab time is to teach you the basics of the Fluent and ANSYS Workbench software programs. You will use these programs in a semester-long project that will result in your graded final proposal. Since there is not enough in-class time to teach you everything you need to know for your project, you will have to spend time outside of class in the computer lab teaching yourself the software features that you will need.

Homework:
- Homework assignments will be announced in class. They will be due in class (usually on Friday).

Exams:
- There will be two exams; one mid-term exam and one final exam.

Final Proposal:
- The final proposal will address a problem that you decide to study using numerical methods, specifically employing the Fluent and ANSYS Workbench software packages.

- The problem must be sufficiently complex and challenging. For example, you may not study a problem that can be solved analytically.
- An Initial Proposal of 1 to 2 pages in length will define the problem, provide background (with references) and show that a numerical simulation is the only tool that can produce a solution.
- A Proposal Update, which consists of a memo-style bulleted list of tasks accomplished to date and remaining tasks to be performed, will be submitted in week 10
- The Final Proposal will be no longer than 10 pages.

Grading: The final percentage grade in the course is based on the following components:

Component	Percentage
Homework	25
Two Exams (20% each)	40
Final Proposal	35
Total	100

The corresponding minimum letter grade a student will receive is listed in the table below.

Percentage Grade		Letter Grade
Greater than or equal to	Less than	
0.0	59.5	F
59.5	66.5	D
66.5	69.5	D+
69.5	72.5	C-
72.5	76.5	C
76.5	79.5	C+
79.5	82.5	B-
82.5	86.5	B
86.5	89.5	B+
89.5	92.5	A-
92.5		A

The final letter grade awarded for the class may be higher than the minimum "earned" letter grade but will never be lower. Additional grading policies are listed in the **Attendance/Policies** section below.

Attendance/Policies: Attendance at all lectures is mandatory. Exceptions to this attendance policy will be made under extraordinary circumstances (e.g. personal or family emergency) or when the student arranges for an absence in advance.

The following additional policies apply during this course.

- Late assignments (unless prior arrangements are made) will be penalized 25%.

- Assignments that are handed in after solutions have been posted will not be given credit.
- Students are expected to act with honesty and respect (see the following)
  - Student Academic Integrity Policy: http://www.d.umn.edu/assl/conduct/integrity
  - Student Conduct Code: http://www.d.umn.edu/assl/conduct/code.
- Unless specific instructions are given to the contrary, working with others on a given assignment is permissible (and encouraged).
- Copying someone else's work is NOT permissible. Copied assignments will be given NO CREDIT.
- Using figures or text from a source without citing the source (plagiarism) is NOT permissible. If there is significant plagiarism within an assignment, the assignment will receive NO CREDIT.
- **Disabilities:** It is the policy and practice of the University of Minnesota Duluth to create inclusive learning environments for all students, including students with disabilities. If there are aspects of this course that result in barriers to your inclusion or your ability to meet course requirements – such as time limited exams, inaccessible web content, or the use of non-captioned videos – please notify the instructor as soon as possible. You are also encouraged to contact the Office of Disability Resources to discuss and arrange reasonable accommodations. Please call 218-726-6130 or visit the DR website at www.d.umn.edu/access for more information.
- **Equal Opportunity:** The University of Minnesota is committed to the practice that all of its students shall have equal educational opportunities. The University expressly forbids discrimination on the basis of race, color, gender, sexual orientation, disability, veteran's status, ethnicity, religion, creed, national origin, or marital status.

Class Assignment and Reading Schedule

Week	Day	Date	Reading Assignment	Topic	Assignment Due
ONE	Wed	19 Jan		Course Introduction	
	Fri	21 Jan	Ch. 1, pp. 1-27	Fluent Tutorial 1	
TWO	Mon	24 Jan	Ch. 2, pp. 29-46	Problem Setup – Pre-Process	
	Wed	26 Jan	Ch. 2, pp. 46-52	Numerical Solution	
	Fri	28 Jan			**Fluent Tutorial 1**

THREE	Mon	31 Jan	Ch. 2, pp. 53-63	Post-Processing	
	Wed	2 Feb	Ch. 3, pp. 65-78	Continuity and Momentum Equations	
	Fri	4 Feb			**Initial Proposal**
FOUR	Mon	7 Feb	Ch. 3, pp. 78-93	Momentum and Energy Equations	
	Wed	9 Feb	Ch. 3, pp. 93-110	Energy Equation and Turbulence Modeling	
	Fri	11 Feb			
FIVE	Mon	14 Feb	Ch. 3, pp. 110-122	Form of Governing Equation and Boundary Conditions	
	Wed	16 Feb	Ch. 4, pp. 126-133	Finite-Difference Method	
	Fri	18 Feb			
SIX	Mon	21 Feb	Ch. 4, pp. 134-139	Finite-Volume Method	
	Wed	23 Feb	Ch. 4, pp. 139-152	Converting Governing Eq'ns to System of Algebraic Eq'ns	
	Fri	25 Feb			
SEVEN	Mon	28 Feb	Ch. 4, pp. 152-157	Direct Solution Methods	
	Wed	2 Mar	Ch. 4, pp. 157-163	Iterative Solution Methods	
	Fri	4 Mar			
EIGHT	Mon	7 Mar	Ch. 4, pp. 163-176	Pressure-Velocity Coupling - SIMPLE	
	Wed	9 Mar		**Review**	
	Fri	11 Mar		**Exam 1**	

Mon, 14 Mar – Fri, 18 Mar Spring Break

NINE	Mon	21 Mar	Online Notes	Additional Convection-Diffusion Models	
	Wed	23 Mar	Online Notes	Pressure-Velocity Coupling – SIMPLEC and SIMPLER	
	Fri	25 Mar			**Proposal Update**
TEN	Mon	28 Mar	Ch. 5, pp. 180-191	Consistency and Stability	
	Wed	30 Mar	Online Notes & Example	Explicit, Implicit and Crank-Nicolson Schemes	
	Fri	1 Apr			
ELEVEN	Mon	4 Apr	Ch. 5, pp. 192-199	Convergence	
	Wed	6 Apr	Ch. 5, pp. 199-212	Accuracy and Efficiency	
	Fri	8 Apr			
TWELVE	Mon	11 Apr	Ch. 5, pp. 212-221	Case Studies	
	Wed	13 Apr	Online Notes	The Four Basic Rules	
	Fri	15 Apr		NO CLASS	
THIRTEEN	Mon	18 Apr	Ch. 6, pp. 224-242	Grid Generation Guidelines	
	Wed	20 Apr	Ch. 6, pp. 242-250	Boundary Condition Guidelines	
	Fri	22 Apr			

FOURTEEN	Mon	25 Apr	Ch. 6, pp. 250-265	Turbulence Modeling Guidelines	
	Wed	27 Apr	Ch. 6, pp. 265-271	Test Case	
	Fri	29 Apr			

FIFTEEN	Mon	2 May		Advanced Topics: TBA	
	Wed	4 May		Advanced Topics: TBA	
	Fri	6 May	**Review**		**Final Proposal**

Final Exam – Ch. 4, 5, and 6 and additional material
Tues, 10 May, 4:00-5:50