ME 5305 - Computational Fluid Dynamics
Spring 2007
M,W,F 9:00 – 9:50 (KPlz 312)

Professor: Daniel N. Pope, Ph.D.
E-mail: dpope@d.umn.edu
Office: VKH 113
Phone: 726-6685
Office Hours: Mon, Wed, Fri 10:00-11:00, Thurs 3:00-4:00 (or by appointment)

Textbook: Required – Patankar, S. V., *Numerical Heat Transfer and Fluid Flow*, Hemisphere Publishing Corp. (1980).

Course Web Page: http://www.d.umn.edu/~dpope/me5305/me_5305.htm.

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. Although there is no lab specifically associated with the course, you will be required to perform tutorials using the Fluent and Gambit software packages. You will therefore have to spend time in the computer lab teaching yourself how to use these software packages.

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

Exams:
- The exams will be OPEN BOOK, CLOSED NOTES.
- You may use one page of handwritten (or typed) notes for each exam.

Final Proposal:
- The final proposal will address a problem that you decide to study using numerical methods, specifically employing the Fluent software package.
- 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 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:** Individuals with any disability, either temporary or permanent, which might affect their ability to perform in this course, are encouraged to inform the instructor at the start of the semester. Adaptation of methods, materials, and/or testing may be modified as required to provide for equitable participation.
- **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	17 Jan		Course Introduction	
	Fri	19 Jan	Ch. 1	Introduction to Fluent	
TWO	Mon	22 Jan		Introduction to Gambit	**Gambit Tutorial 1**
	Wed	24 Jan	Notes	Solving Sets of Algebraic Eq'ns Matrix Notation, Gauss Elimination	
	Fri	26 Jan			
THREE	Mon	29 Jan	Notes	Thomas Algorithm, LU Decomposition, Cramer's Rule, Matrix Inversion	**Fluent Tutorial 1**
	Wed	31 Jan			
	Fri	2 Feb	Notes	Jacobi, Gauss-Seidel, SOR and Newton's Methods	**Initial Proposal**
FOUR	Mon	5 Feb			
	Wed	7 Feb	Notes	Conservation of Energy/Conduction	Hmwk #1
	Fri	9 Feb	Notes	Discrete Approximation of Derivatives	

FIVE	Mon	12 Feb			
	Wed	14 Feb	Notes	Steady One-Dimensional Conduction	Hmwk #2
	Fri	16 Feb		**NO CLASS!**	

SIX	Mon	19 Feb	Notes	Transient One-Dimensional Conduction	
	Wed	21 Feb	Notes, Example	Explicit, Implicit and Crank-Nicolson Schemes	Hmwk #3
	Fri	23 Feb			

SEVEN	Mon	26 Feb	Notes	Steady Multidimensional Conduction	
	Wed	28 Feb	Notes	Transient Multidimensional Conduction	Hmwk #4
	Fri	2 Mar	Example	Transient Multidimensional Conduction	

EIGHT	Mon	5 Mar	Notes	Diffusive/Convective Systems	
	Wed	7 Mar		**Review**	Hmwk #5
	Fri	9 Mar		**Exam 1 – Finite-Difference**	

Mon, 12 Mar – Fri, 16 Mar Spring Break

NINE	Mon	19 Mar	Ch. 2, pp. 11-22	Governing Equations, Nature of Coordinates	
	Wed	21 Mar		Governing Equations, Nature of Coordinates	
	Fri	23 Mar			

TEN	Mon	26 Mar	Ch. 3, pp. 25-31	Methods of Deriving the Discretization Equation, Illustrative Example	**Proposal Update**
	Wed	28 Mar	Ch. 3, pp. 36-39	The Four Basic Rules	
	Fri	30 Mar	Ch. 4, pp. 41-51	Steady One-Dimensional Conduction	

ELEVEN	Mon	2 Apr		Steady One-Dimensional Conduction	
	Wed	4 Apr	Ch. 4, pp. 54-61	Transient One-Dimensional Conduction	Hmwk #6
	Fri	6 Apr		Transient One-Dimensional Conduction	

TWELVE	Mon	9 Apr	Ch. 4, pp. 52-54, 61-74	Solution of the Algebraic Equations, Geometric Considerations	
	Wed	11 Apr	Ch. 5, pp. 79-96	Steady One-Dimensional Convection and Diffusion	Hmwk #7
	Fri	13 Apr		Steady One-Dimensional Convection and Diffusion	

THIRTEEN	Mon	16 Apr	Ch. 5, pp. 96-109	Discretization Equation for Two and Three Dimensions	
	Wed	18 Apr	Ch. 6, pp. 113-126	Pressure-Correction Equation for Staggered Grids	Hmwk #8
	Fri	20 Apr		Pressure-Correction Equation for Staggered Grids	

FOURTEEN	Mon	23 Apr	Ch. 6, pp. 126-134	The SIMPLE and SIMPLER Algorithms	
	Wed	25 Apr		The SIMPLE and SIMPLER Algorithms	Hmwk #9
	Fri	27 Apr	TBA	Additional Topics	

FIFTEEN	Mon	30 Apr	TBA	Additional Topics	
	Wed	2 May	TBA	Additional Topics	
	Fri	4 May	**Review**		**Final Proposal**

Final Exam – Ch. 4, 5, and 6 and additional material
Mon, 7 May, 8:00-9:55