ChBE 3200A
Transport Phenomena I
Fall 2012

General Course Information

INSTRUCTOR:

Dr. Victor Breedveld
Room 1222 ES&T
(404) 894-5134
victor.breedveld@chbe.gatech.edu

TEACHING ASSISTANT:

Emily Peterson
Room 4121 MoSE building
emilycpeterson@gatech.edu

COURSE PREREQUISITES:

ChBE 2110 and 2120, Math 2403, Phys 2211

MEETING TIMES:

Mon/Wed/Fri 8:05 - 8:55am, ES&T L1105

TEXT:

Fundamentals of Momentum, Heat and Mass Transfer, 5th ed,
J.R. Welty, C.E. Wicks, R.E. Wilson, G. Rorrer, John Wiley & Sons, Inc. (2008).

CLICKERS:

Clickers (ResponseCard NXT; Turning Technologies) will be used during this class. Each student must obtain a transmitter (available at the GeorgiaTech Bookstore), register it via T-Square and bring it to class every day. The clickers will be used to record class attendance ***starting on Friday 8/24***. Without a clicker, your attendance cannot be registered. Use of the "mobile clickers" will not be permitted for this course.

OFFICE HOURS:

Dr. Breedveld:
Mondays 1:30-2:30pm (ES&T 2320) *&* ***Thursdays 2:00-3:00pm (office);*** except when faculty meetings, seminars, thesis defense presentations, etc. are scheduled. Drop-ins and appointments are welcome, but outside office hours immediate instructor availability cannot be guaranteed. Long email questions are difficult to answer and thus strongly discouraged. Stop by the office and we will be better able to assist you.

RECITATION SESSIONS:

Emily Peterson (Teaching Assistant):
Tuesdays 4:30-6:00pm (ES&T L1105)
Recitation sessions will be led by the TA and focus on review of course material and in-class solution of problems that are not part of the homework assignments. These sessions are very important for learning to master the course material and application of the material taught during lectures. These sessions are highly recommended.

PROBLEM SOLVING SESSIONS:

The syllabus lists six Problem Solving Sessions, which take place on Wednesdays (generally from 5:30 - 7:00pm in **ES&T L1105**). These are optional sessions, during which the participants will solve one or two problems under the guidance of the instructor. The objective of these sessions is to enhance students' problem solving skills, in particular the development of successful strategies to efficiently translate the written problem statement into a correct solution.

COURSE UPDATES:

Syllabus and class updates (homework, announcements, etc.) will be posted on the T-Square course website.

HOMEWORK:

Homework assignments will be provided (almost) every week, as indicated on the course syllabus. However, only 50% of homework sets (odd numbers, marked with * on the syllabus) will be collected for grading. Detailed solutions will be posted for all homework sets on the class website on the date indicated on the syllabus.

Homework submission for grading are due **before the start of class** on the date indicated on the assignment. **Late submissions (more than 5 minutes after the start of class) will not be accepted**.

- Students are encouraged to work in groups, but **each student must submit an original homework (no copying).**
- **Copying problem solutions from other students, solution manuals, or any other source is viewed as academic misconduct** and will be dealt with according to policies stated below.
- Homework solutions must be on clean Letter format paper (8.5 x 11in). In case of illegible/unclear assignments, the homework will not be graded by the teaching assistant and no points will be awarded.
- Not all problems in a submitted homework assignment will be graded; *it will be decided randomly **after the submission deadline** which problems will be graded*.
- A 0-3 point scale will be used for homework grading:

Correct approach and correct solution	*3*
Correct approach but incorrect answer due to minor mistake	*2.5*
Correct approach but incorrect answer due to major issue	*2*
Sincere but incorrect approach	*1*
Scribbled down problem statement	*0*

- One (1) **bonus point** will be added to the total score for each graded homework assignment, if sincere solutions to **all** problems in that assignment are submitted, including problems that are not graded.
- Any conflict about homework grades must be resolved within one week after the graded work has been returned to the class.

EXAMS:

Three (3) mid-term exams will be given on **Tuesday 9/18 (evening), Thursday 10/18 (evening),** and **Wednesday 11/14 (morning)**. No make-up exams will be given. All midterm exam scores count towards the final grade, but the lowest exam grade of each student will be weighed less (weighing factors 2:2:1)**.**

A final exam will be given during exam week *(tentatively scheduled on Monday 12/10 at 8:00am)*.

Only certified medical excuses or equivalents will be accepted for missing exams. A student missing an exam should contact Dr. Breedveld as soon as possible and definitely **before** the exam.

All exams are closed book, closed notes. An equation sheet will be provided for each exam by the instructor; for the final exam ONLY, use of a cheat sheet will be allowed. The use of wireless devices is prohibited at all times. Programmable calculators are allowed during the second part of the exams only.

COURSE GRADE:

Homework	50 points
Quizzes	50 points
Class Participation	40 points
Midterm exams	300 points (120/120/60)
Final Exam	200 points
Project	60 points
Total	***700 points***

ATTENDANCE POLICY:

Class attendance is mandatory and will be recorded (via the PRS system starting on Friday 8/24); attendance plays an important role in determining the class participation grade. **Five (5) unexplained absences will be allowed during the semester; any absence in excess of these five will result in an automatic 4-point deduction from the class participation grade. Unexcused absences include medical and other certified excuses, so they should be used wisely.** Please note that attendance will generally be recorded at the beginning of class; late entries will be counted as full absences.

QUIZZES:

A number (between 6 and 8) of short (10-15 minutes), unannounced quizzes will be given during class, mostly at the start of class. The material covered in these quizzes will be closely related to assigned homework problems.

COURSE OBJECTIVES:

Upon satisfactory completion of this course, students will be able to:

1. Design/simulate the operation of process piping systems (estimate frictional losses, size pipes, size pumps, etc.) for the specific flow of liquids and gases.
2. Design/simulate the operation of packed beds, fluidized beds, and filters for specified fluid flow rates.
3. Apply the differential continuity equation and the Navier-Stokes equations of motion to simple systems using both Cartesian and cylindrical coordinates.
4. Apply Fourier's Law of heat conduction to homogeneous and heterogeneous objects of various shapes.
5. Estimate transient and steady state heat transfer rates from/to objects such as tanks, pipes, buildings, etc.
6. Apply principles of radiative heat transfer

TEACHING PHILOSOPHY AND EXPECTATIONS:

In this class, the expectation will be that **students study the relevant course material ahead of the lectures covering each topic**. The objective of this practice is to enable an immediate response of the instructor to students' questions and misconceptions, thus

enhancing the value of lectures. The underlying philosophy is that if students wrestle with new material before the lectures, the instructor will be able to focus more on conceptual understanding and example problems than in a regular course design.

In order to encourage advance studying, roughly one-third of assigned homework problems will consist of “look-ahead-problems”, which cover material that has not been discussed in class yet. Although these “look-ahead-problems” may appear more challenging than regular after-the-fact assignments, it has been shown in educational research that the associated self-learning process yields a better understanding of the course material. “Look-ahead-problems” will be designated as such on the assignment and hints will be provided on which parts of the book should be studied before attempting to solve them.

ACADEMIC MISCONDUCT:

Students in this class are expected to abide by the Georgia Tech Academic Honor Code at all times. **All work turned in for grading must be original.** Students will be asked to acknowledge their acceptance of these stipulations and their willingness to abide by all terms of the Academic Honor Code by signing an "Honor Agreement" attached to each exam. The complete text of the Academic Honor Code is available on the website of the Office of Student Integrity: ***http://www.osi.gatech.edu/.***

All violations of the Honor Code (without exception) will be reported to the Office of the Dean of Students with the following recommended repercussions:

- **First-time offenders** *(in this course)***: lowering course letter grade by one letter**
- **Repeat offenders: course letter grade “F” (failure of the course)**

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Syllabus, page 1/2

Lecture Number and Date				Reading*	Lecture Topic
1	M	20	August	1.1-1.5	Introduction, Notation, Fluid Stresses
2	W	22	August	1.6	Surface tension
3	F	24	August	**2.1-2.4**	Pressure, Buoyancy **(HW 1)***
4	M	27	August	3.1-3.5	Fluid Motion, Control Volume
5	W	29	August	4.1-4.3	Macroscopic Mass Balance, Average Velocity **(HW 2)**
6	F	31	August	5.1-5.2	Macroscopic Momentum Balances
	M	*3*	*September*		*Labor Day*
7	W	5	September	6.1-6.4	Macroscopic Energy Balance, Bernoulli Balance
	Wednesday September 5, 5:30-7pm				*Problem Solving Session*
8	F	7	September	7.1-7.5	Shear Stress, Laminar Flow, Turbulence **(HW 3)***
9	M	10	September	8.1-8.3	Shell Momentum Balance, Velocity Profile
10	W	12	September	HO§	Non-Newtonian fluids, Pipe Flow **(HW 4)**
	Wednesday September 12, 6:30-7:30pm				*Problem Solving Session*
11	F	14	September	9.1	Differential Mass Balance: Continuity Equation
12	M	17	September	9.2	Navier-Stokes Equations
	Tuesday, September 18				**Exam 1, 6:00-7:30pm, Chapters 1 – 7**
13	W	19	September	9.2	Navier-Stokes Equations
14	F	21	September	11.1-11.3	Dimensional Analysis
15	M	24	September	11.1-11.3	Dimensional Analysis, Similarity
16	W	26	September	11.4-11.5	Buckingham Π Method, Model Analysis **(HW 5)***
	Wednesday September 26, 5:30-7pm				*Problem Solving Session*
17	F	28	September	12.1-12.5	Boundary Layer Theory, Form Drag
18	M	1	October	12.7-12.8	Boundary Layer Theory
19	W	3	October	13.1-13.2	Mechanical Energy Balance, Frictional Losses **(HW 6)**
20	F	5	October	13.3-13.4	Mechanical Energy Balance, Friction Factor
21	M	8	October	13.4, HO	Piping Networks
22	W	10	October	13.4, HO	Mechanical Energy Balance **(HW 7)***
23	F	12	October	HO	Packed Beds

* Readings refers to sections in ***Fundamentals of Momentum, Heat and Mass Transfer,*** **5th edition**, J.R. Welty, C.E. Wicks, R.E. Wilson and G. Rorrer, John Wiley & Sons Inc. (2008).

§ Hand Out or additional material.

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Syllabus, page 2/2

Lecture Number and Date				Reading	Lecture Topic
	M	*15*	*October*	*Fall Break*	
24	W	17	October	HO	Fluidized Beds
	Thursday, October 18: Exam 2, 6:30-8:00pm, Chapters 8 - 13 + HOs				
25	F	19	October	HO	Filtration
26	M	22	October	5.4, 14.1, HO	Pumps - Principles
27	W	24	October	14.1-14.2	Pumps - Head, Lift, Cavitation, Pump curves **(HW 8)**
	Wednesday October 24, 5:30-7pm				*Problem Solving Session*
28	F	26	October	14.3-14.5, HO	Pumps and Turbines
29	M	29	October	15.1-15.2	Conductive Heat Transfer, Fourier's Law
30	W	31	October	15.3-15.5	Combined Mechanisms of Heat Transfer **(HW 9)***
31	F	2	November	HO	Cardiovascular Circulation
32	M	5	November	16.1	Differential Energy Balance
33	W	7	November	16.2-16.3	Differential Energy Balance- Boundary Conditions
	Wednesday November 7, 5:30-7pm				*Problem Solving Session*
34	F	9	November	16.1-16.4	Differential Energy Balance – Examples **(HW 10)**
35	M	12	November	17.1-17.2	One-Dimensional Steady-State Conduction
36	**Wednesday, November 14: Exam 3, 7:30-9:00am, Chapters 14 - 16 + HOs**				
37	F	16	November	17.1-17.2	One-Dimensional Steady-State Conduction
38	M	19	November	17.3	Heat Transfer from Extended Surfaces
39	W	21	November	17.4	Multi-Dimensional Conduction **(HW 11)***
	F	*23*	*November*	*Thanksgiving Break*	
40	M	26	November	18.1-18.3	Transient Heat Conduction
41	W	28	November	18.5	Transient Heat Conduction, Numerical Methods
	Wednesday November 28, 5:30-7pm				*Problem Solving Session*
42	F	30	November	23.1-23.4	Radiation Heat Transfer, Concepts
43	M	3	December	23.5-23.6	Radiation Heat Transfer
44	W	5	December		Example problems, exam preparation **(HW 12)**
45	F	7	December		Example problems, exam preparation

Monday December 10, 8:00-10:50am: Final exam