CHBE 3200: Transport Phenomena I
Summer Semester, Georgia Tech Lorraine, 2019
Instructor: Prof. Mark Styczynski

Course objectives:
This course introduces the fundamental concepts of momentum and heat transfer as well as their use in typical engineering applications. Special emphasis is put on analogies between the balance equations of fluid flow and heat flow, on dimensional analysis, and the prediction of friction losses. Applications include the analysis and design of flow models, piping networks, packed and fluidized beds, as well as insulation and heat transfer devices.

Learning outcomes:
By the end of this course, a student should 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. Design flow models and interpret experimental data using dimensional analysis.
4. Apply the macroscopic balances of mass, momentum, and energy, as well as the differential continuity equation and the equations of motion to simple systems using both Cartesian and polar coordinates.
5. Apply the Fourier law of heat conduction to homogeneous and heterogeneous objects of various shapes.
6. Estimate transient and steady state heat transfer rates from/to object such as tanks, pipes, buildings, etc.
7. Apply principles of radiative heat transfer

Text:
Welty JR, Rorrer GL, and Foster DG. "Fundamentals of Momentum, Heat, and Mass Transfer", sixth edition, Wiley, 2014.

Prerequisites:
CHBE 2130, CHBE 2120, PHYS 2211, MATH 2401/2551 or equivalent multivariable calculus, MATH 2403/2552 or equivalent differential equations

Class website:
https://gatech.instructure.com/courses/63770

Class time and location:
Days 1, 2, 3, and 4, 10:35 AM – 12:25 PM, Georgia Tech Lorraine

Instructors:
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Office hours: To be set based on consensus class availability

TAs: TBD (see Canvas for final days/times/BlueJeans links)
UGCA: TBD (see Canvas for final days/times/BlueJeans links)
Prof. Styczynski: TBD (see Canvas for final days/times) and by appointment, 103B
(All office hours determined based on consensus student availability)

Grading:

Exam 1:	22%	Quizzes:	15%
Exam 2:	22%	Homework:	10%
Final Exam:	31%		

Participation: up to 1% extra

Participation is strongly encouraged, and essentially amounts to extra credit in this class. It is likely to help your learning, it helps others' learning, and it will help your grade. <u>Participation is defined as answering and asking questions in class, and answering questions in Piazza</u>. But **please note: these 1% extra points are not yours by default**. If you ask one question a month in class about whether I have written a "Z" or a "2", that is not worthy of getting extra credit added on to your grade. This is for those who continually participate, engage, and try.

Exams:

Two exams will be given in addition to the final exam. All exams will be closed book and closed notes, and the instructor will provide equation sheets. The use of electronic devices other than a calculator is prohibited at all times. It is expected that no additional notes or information will be stored in any calculator in advance of the exam for use during the exam; violation of this rule will be viewed as a violation of the Honor Code.

The midterm exams will be held in class on the following dates:

Exam 1: Wednesday, July 3
Exam 2: Friday, July 18

Midterm exams will be approximately 75 minutes in length, and after a brief break will be followed by approximately 25 minutes of new instruction.
The institute has assigned the following date and time for the final exam:

Monday, July 29, 1:30 PM – 4:30 PM

If you have any conflicts with these exam dates, you must contact Prof. Styczynski in writing by the end of the second week of class to resolve this conflict.

Quizzes:

<u>At least</u> five quizzes will be given during class. The two lowest scores will be dropped in computing the overall quiz grade. The quiz dates will often not be announced ahead of time, but may be hinted at during class, and are likely to be shortly after significant changes in topical content. If you need to miss class <u>for any reason</u> and you miss a quiz, then you will receive a zero for that quiz.

Homework:

Homework assignments will be due every class, except for Mondays and exam days. Detailed solutions will be made available for all homework sets shortly after their deadline.

Homeworks are due <u>**at the start of class (10:35 AM Central European Time) on the due date,**</u> though it can be turned in any time before that as well. **Late homework (anything after 10:40 AM) will not be accepted and will receive a grade of zero**.

<u>Collaboration policy</u>: All homework turned in must be your own work. Students may discuss technical concepts relating to the homework with classmates, and are in fact encouraged to work in groups to identify problem-solving strategies, but each student must <u>work the problems him/herself and submit an original homework (no direct copying)</u>. Copying from another person's homework, solution manuals, or any other source is considered a serious violation of the Georgia Tech Honor Code (http://osi.gatech.edu/content/honor-code).

Please submit homework solutions for grading via Canvas as a single PDF file. You may use scanners in the computer lab, or you may use a smart phone to take pictures and send them. There are multiple free apps (for example, Office Lens) that allow easy creation of PDFs from pictures. Solutions must be legible in order to receive credit from the grader. Please make sure you check your PDF files before uploading to make sure they are legible!

Also, please make sure you confirm that your work has been properly uploaded and submitted to Canvas! I haven't yet used Canvas for electronic submissions, but I imagine that (just like on T-Square) it is possible to upload a file and think you've submitted it when you actually haven't.

For each homework set, not all problems will be graded; a subset (approximately 50%) of the problems in each graded homework set will be randomly selected after the submission deadline as those which will be graded.

A 3-point holistic scale will be used for grading of each problem:

Correct approach, correct solution:	3 points
Correct approach, incorrect solution due to minor mistake:	2.5 points
Correct approach, incorrect solution due to major issue or multiple minor mistakes:	2 points
Sincere and complete solution effort but incorrect approach:	1 point
Not much more than restating the problem statement:	0 points

One additional point will be added to the total possible score for each graded homework assignment, and will be awarded if a sincere and complete solution effort is provided for all problems in the set, including those which are not randomly selected to be graded.

Regrades:

Requests for regrading of a homework assignment or an exam may be submitted in writing within one week of the day the assignment/exam is handed back to the class (regardless of whether or not you attend class that day). You must justify in writing the technical basis for the regrade request. The entire homework or exam will be regraded, meaning your grade may go up or down.

Piazza:

On Canvas, the "Piazza" message board feature has been activated. Questions regarding specific issues in the homework assignments or overall concepts should be posted here rather than emailed directly to the professor or the TAs. This helps your classmates see what problems others are experiencing and will hopefully make them more successful in their homework and studying efforts. The ultimate goal of using these forums is that everyone can learn more from the failures and successes of others by sharing.

Piazza posts directly related to homework assignments will generally not be responded to by the professor or TAs for 4 hours (except for clarification and typo questions). Those first 4 hours are for other students to respond to questions. Answering questions and helping others reinforces your learning by solidifying concepts. Please note that helpful responses to messages posted in Piazza will count towards "Participation" (see Grading section).

Again, all conceptual/homework questions and communication should be done via Piazza. This is the only way that Prof. Styczynski, who is currently extremely bad at email, can be sure that all such questions have been answered. Only personal/private communications should be sent via email to the instructor, though in many cases a "private" Piazza post is a safer bet for Prof. Styczynski to see it.

Honor Code:

All work done in the class, including quizzes, exams, projects, and homework assignments, is done under the Georgia Tech Honor Code (http://osi.gatech.edu/content/honor-code). Students are expected to follow the policies outlined in the Georgia Institute of Technology Academic Honor Code. Infractions will receive a zero for the assignment and will be reported to the Dean of Students for disciplinary action.

Attendance Policy:

There will be no enforcement of a formal class attendance policy this semester. However, I have spoken with previous GTL 3200 instructors, and so I feel I should advise you that, based on historical data, success in this course depends strongly on the level of engagement with the course material. Actively participating in all lectures and taking advantage of other learning opportunities offered (homework, office hours, etc.) is critical, especially in the fast-paced schedule at GTL.

Expectations – reading and thinking ahead:

In this course, the expectation will be that students study the relevant course material ahead of the lectures covering each topic. The objective is to enable an immediate response of the instructor to students' questions and misconceptions, thus enhancing the value of lectures and in-class problem solving. The underlying philosophy is that if students wrestle with new material before the lectures, the instructor will be able to focus more effectively on conceptual understanding and example problems.

In order to encourage advance studying, some of the assigned homework problems will be "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 results in much better understanding of the course material. "Look-ahead-problems" will be designated as such on the assignment and extra hints will be given on which parts of the book should be studied before trying to solve them.

Tips for Success:

- **Do** the assigned reading before class so that you can be prepared to ask questions about things that are confusing or unclear.
- **Do not** be afraid to ask questions and interact in class.
- **Do** take homework assignments seriously. They confirm that you understand key concepts and may even introduce variations on those concepts.
- **Do not** fall behind. Later topics depend heavily on earlier topics.

Class Calendar:

The schedule listed below is aggressive/optimistic, so it is likely subject to significant change in terms of dates that topics are covered. Cardiovascular circulation, pre-exam review on the last day, and the second hour of radiation heat transfer are the most likely things to be eliminated as we slip behind this schedule. Also, if we get very far behind, then the chapters covered by Exams 1 and 2 may change. Changes will be reflected on the version of this syllabus that is posted on the course Canvas site.

Date	Topic	Reading	Comments
6/18	Intro, notation, fluid stresses	1.1-1.4	
	Surface tension, pressure	1.5-1.6, 2.1	
6/19	ChBE 3130 Final Exam		Good luck!!!
6/20	Acceleration, buoyancy	2.2-2.4	HW 1 Due
	Fluid motion	3.1-3.4	
6/24	Control volume	3.5, 4.1	
	Macroscopic mass balance, average velocity	4.2-4.3	
6/25	Macroscopic momentum balances	5.1-5.2	HW 2 Due
	Macroscopic energy balances	6.1-6.2	
6/26	Bernoulli equation	6.3-6.4	HW 3 Due
	Shear stress	7.1-7.3	
6/27	Laminar flow	7.4-7.5	HW 4 Due
	Shell momentum balance	8.1-8.3	

7/1	Differential mass balance: Continuity equation	9.1	
	Navier-Stokes equations	9.2	
7/2	Navier-Stokes equations		HW 5 Due
	Dimensional analysis, Buckingham π	11.1-11.3	
7/3	**Exam 1**	**Chapters 1-9**	**Exam 1**
	Model analysis, form drag	11.4-11.5, 12.1-12.2	
7/5	Boundary layer theory	12.3-12.8	HW 6 Due
	Mechanical energy balance	13.1-13.2	
7/8	Frictional losses	13.3-13.4	
	Friction factor	Handouts	
7/9	Packed and fluidized beds	Handouts	HW 7 Due
	Packed/fluidized beds, Pumps	14.1-14.2	
7/10	Pumps: head, lift	Handouts	HW 8 Due
	Pumps: Cavitation, pump curves	14.3-14.5, handouts	
7/11	Conductive heat transfer	15.1-15.2	HW 9 Due
	Convection and radiation	15.3-15.4	
7/15	Combined mechanisms of heat transfer	15.5	
7/16	Differential energy balance	16.1-16.2	HW 10 Due
	Boundary conditions	16.3-16.4	
7/17	Cardiovascular circulation	Handouts	HW 11 Due
	1-D Steady-state conduction	17.1	
7/18	**Exam 2**	**Chapters 11-16, handouts**	**Exam 2**
	1-D Steady-state conduction		
7/22	Internal generation, extended surfaces	17.2-17.3	
	2D and 3D conduction	17.4	
7/23	Transient heat conduction	18.1	HW 12 Due
	Charts and numerical solutions	18.2-18.3	
7/24	Radiation heat transfer	23.1-23.4	HW 13 Due
	Radiation heat transfer	23.5-23.6	
7/25	Exam prep		HW 14 Due
	Exam prep		

FINAL EXAM: Monday, July 29, 1:35 PM – 4:25 PM