CHBE 422 - Transport Phenomena I: Fluid Dynamics

Department of Chemical and Biomolecular Engineering
University of Maryland
Fall 2017

COURSE INFORMATION

Prerequisites:	Minimum grade of C- in CHBE101, CHBE250, MATH241, and MATH246		
Lectures:	Tuesday & Thursday	2:00 to 3:15 pm	CHE 2108
Discussion:	Friday	1:00 to 1:50 pm	JMP 3201

Instructor:
Dr. Deborah S. Goldberg
Office: ChE 2113C
Email: dsgold@umd.edu
Phone: 301-405-1885

Course Description (from testudo): Principals of fluid dynamics as applied to model development and process design. Mass, momentum and energy conservation. Statics and surface tension. Equation of Continuity and Navier-Stokes Equation with application to laminar flow. Dimensional analysis. Macroscopic balances, Bernoulli Equation and friction factors with application to turbulent flow.

Teaching Team:

Supriya Padmanabhan (TA)	Email: supriya@umd.edu
Sam Preza (UTF)	Email: spreza10@terpmail.umd.edu
Nina Uchida (UTF)	Email: nvuchida@terpmail.umd.edu

LEARNING RESOURCES

Office Hours: (also available by appointment):

Tuesday	11:00 am - 12:30 pm	Dr. Goldberg	Room ChE 2113C
Wednesday	11:00 am - 12:00 pm	Samuel Preza	Room ChE 2145
Thursday	11:00 am - 12:00 pm	Supriya Padmanabhan	Room ChE 2108
Thursday	12:00 pm - 1:00 pm	Nina Uchida	Room ChE 2113A

422 Learning Community:

Tuesday	3:30 pm -4:30 pm	Dr. Goldberg	Room KEB 1110

OXE Tutoring:
OXE Tutoring information will be communicated when available.

Textbook:
A custom textbook will be used in this class. The custom text contains only the chapters needed for CHBE422 and represents considerable cost-savings compared to the full textbook. Since students are not permitted to use the textbook on quizzes or exams, either hard copy or e-text format is acceptable.

A binder-ready version can be purchased from the University of Maryland bookstore:
CHBE422: Transport Processes I for University of Maryland College Park, ISBN: 9781119463764

An e-text version is available through VitalSource:
CHBE422: Transport Processes I - eBook for University of Maryland College Park, ISBN: 9781119463740
https://www.vitalsource.com/custom/9781119463740

Students may also opt to purchase the full textbook:
Bird, R.B., **Introductory Transport Phenomena**, John Wiley & Sons, 2014.
Hardcover: ISBN : 978-1-118-77552-3, **E-text:** ISBN : 978-1-118-95372-3

Supplemental Material: Will be posted to course website as needed.

COURSE OBJECTIVES & PERFORMANCE CRITERIA

Objectives:
1. To teach students the basic principles of fluid dynamics, and to develop within them the ability to apply these principles to a variety of contemporary problems in engineering research and practice.
2. To teach students to develop and assess mathematical models which describe a variety of fluid flow phenomena, and to apply these models to the design of devices and flow processes.
3. To expose students to a variety of approaches for solving flow problems, and to develop within them the ability to select the most appropriate approach for solving the problem at hand.
4. To teach students to design various flow and piping networks at various process time and length scales.

Performance Criteria:
1. Students will demonstrate that they can work independently on homework and exam problems, and that they can use a variety of resources and tools from this course, previous courses and life experience to solve problems.
2. Students will demonstrate an understanding of the principles of conservation of mass, momentum and energy, by applying them to a spectrum of fluid flow problems. These can range from straight forward extensions of classroom and textbook material, to problems not previously considered.
3. Students will demonstrate an ability to physically visualize flow problems, to make rational assumptions on which to base a model, and to apply basic mathematical skills and fluid dynamical principles to develop models for a variety of processes. These can range from straightforward extensions of classroom and textbook problems to those not previously considered.
4. Students will demonstrate that they can apply generic models to the design of a variety of flow devices and processes, and that they can critically assess the validity of their results.
5. Students will demonstrate that they can rationally choose among a variety of approaches and modeling techniques to solve fluid flow problems.
6. Students will demonstrate familiarity with the spectrum of flow behavior that can occur in pipes, tubes, tanks and other devices. They will further demonstrate that they can apply models developed in class, the textbook and homework exercises to the design of these systems.

COURSE EXPECTATIONS

Faculty Expectations of Students:

- Review prerequisite course materials.
- Complete out of class assignments on time.
- Come to class prepared (having read the assigned textbook material) and on time.
- Participate in the classroom by asking and responding to questions and engaging in group activities.
- Get help and feedback from the instructor and teaching assistants, as needed.
- Treat instructor, teaching assistants and fellow students professionally, and with respect.
- Follow the university code and departmental policy on Academic Integrity.
- Write out and sign the University of Maryland Honor Pledge on all assignments and examinations, as well as abide by its principles.

Student Expectations of Faculty:

- Provide written documentation and dialog on what is expected of students, course objectives and content, and performance criteria and evaluation procedures.
- Hold advertised office hours and be available at other times, by appointment.
- Put course material in context by relating it to life experiences, career related problems and applications, contemporary issues in engineering research and practice, and the content of other courses.
- Respect students and be receptive to their questions and opinions.
- Treat students fairly and equitably.
- Come to class prepared and on time.
- Return graded material in a timely fashion.
- Set examinations appropriately for the material being tested.
- Provide continual feedback on student performance.

COURSE POLICIES

This course will adhere to university policies relevant to Undergraduate Courses are found here: http://ugst.umd.edu/courserelatedpolicies.html
Topics that are addressed in these various policies include academic integrity, student and instructor conduct, accessibility and accommodations, attendance and excused absences, grades and appeals, copyright and intellectual property. In addition, links to full policies on excused absences and academic dishonesty can be found below. Students are expected to read and understand these policies.

Documented excused absences are required to make up any quiz or examination.

Excused Absence Policy:
http://www.president.umd.edu/sites/president.umd.edu/files/documents/policies/V-1.00G.pdf

Academic Integrity Policy:
http://www.president.umd.edu/sites/president.umd.edu/files/documents/policies/III-100A.pdf

COURSE FUNDAMENTALS

Course website

The course website is on ELMS: https://myelms.umd.edu/login. The course website will be used for posting course material, announcements, and grades. Ensure the email address you have associated with ELMS is current, as course information will be communicated through the ELMS messaging system.

If you are having difficulty with ELMS/Canvas, do not contact the instructor for technical support. The University has professional 24-hour support for students: (877) 399 – 4090

Lecture

Lectures will typically be given by the instructor, though occasionally another qualified person may substitute or a recording may be posted on ELMS. Lectures will be the primary means to deliver new information. Lectures will include active participation to enhance learning.

Discussion

The discussion period is an opportunity to strengthen your understanding of course material. Discussion sections will include a review of the most important concepts from the week and an overview of homework solutions. Quizzes will also be given during discussion (see schedule). Select discussion sections will be used as lecture periods (see schedule).

422 Learning Community

After lecture on Tuesdays, 422 learning community will provide students with the space and time to work on the week's homework assignment peers. Dr. Goldberg will be available to answer questions and facilitate group problem solving.

Communication with the Instructor

Email is the best way to reach the instructor outside of office hours. A reply to email can be expected within two business days. Email should be used to notify the instructor of planned and/or excused absences and can be used to ask clarifying questions on assignments. **Any in depth questions on course material or homework assignments and any questions regarding grading or student progress should be addressed in person.**

Classroom Environment

Students are expected to contribute to a classroom environment that is conducive to learning. As such, please observe the following during class:

- Interact with all instructors and classmates in a respectful and professional manner. Behaviors and remarks perceived to constitute teasing or harassment will not be tolerated.
- Keep talking to a minimum outside of organized group activities. It is difficult for others to listen if there is background conversation taking place. If there is a question, please ask.
- Refrain from using electronic devices. The only electronic devices that you should need to use are calculators. E-mailing, texting, tweeting, and consuming any form of digital media can be distracting to your fellow students. Please leave the classroom if you need to use a device (in emergencies only).

Path to Success/ Expected Time Commitment:

Traditionally, students are expected to devote 2-3 hours of time per week outside of class per credit hour—6-9 hours per week for a 3 credit class. As a challenging upper level chemical engineering class, you should plan to spend approximately 9 hours per week on CHBE422. **The only way to succeed in this class is to put in the time to review notes, work through homework problems (independently first) and think critically about the course material.** If you are overcommitted and do not have sufficient time to spend on the course, you will likely earn a lower grade than you desire.

Resources Available:

If you are struggling to understand and keep up with course material GET HELP EARLY. Because of the cumulative nature of the material, falling behind can make it almost impossible to catch up. Many resources are available for extra help including:

- Instructor Office hours
- TA/UTF Office hours
- 422 Learning Community
- OXE Tutoring
- LearnChemE and other online videos
- Peer study groups

In addition, the campus's **Learning Assistance Services** offers guidance on building good study habits, time management skills, exam preparation, etc.
https://counseling.umd.edu/las/

Finally, the **Counseling Service** in the Counseling Center provides free and confidential therapy to help UMD students manage personal, social, and academic challenges.
https://www.counseling.umd.edu/cs/

Arrangements for Students with Disabilities

The University is legally obligated to provide appropriate accommodations for students with disabilities. Please contact Disability Support Service (DSS) Office (301) 314 – 7682 or Dissup@umd.edu or visit their website: http://www.counseling.umd.edu/DSS/
If you have an accommodation letter from DSS indicating that you have a disability which requires academic accommodations, please present it by the end of the schedule adjustment period (September 11, 2017) so we can discuss the accommodations that you might need in this class.

University Closures or Delays

If class is affected by a University closure or delay, the instructor will email the class concerning the impact to the missed class meeting and will distribute an updated course schedule.

Copyright Statement

All materials presented or provided in class and on the course website (e.g., lectures, handouts, videos, slides) are copyright protected. Students may not copy, record, or distribute these materials without the instructor's permission.

EVALUATION

Grading Policy

There will be a total of 1000 points from during the semester. Details on each item follow.

Homework:	10% (Highest 10 @ 10 points each)
Quizzes:	10% (Highest 4 @ 25 points each)
Reflections:	3% (3 @ 10 points each)
Project:	12% (120 points)
Exams:	40% (2 @ 200 points each)
Final Exam:	25% (250 points)

Grading Scale

This course will use a +/- grading system with letter grades equivalent to the following point values: 895-1000 points (90-100%): A-/A/A+; 795-894 points (80-89%): B-/B/B+; 695-794 point (70-79%): C-/C/C+; 595-694 points (60-69%): D-/D/D+; <595 points (<60%) = F
The instructor shall reserve the right to lower the cut-off points at the end of the semester.

Homework Assignments

Eleven homework exercises will be assigned during the semester. Only the highest ten scores will be counted towards the final grade. Assignments will be posted to Canvas on Fridays and due the following Friday (1 week to complete). Homework is due at the beginning of discussion period (1:00 pm on Fridays). **Late homework will not be accepted except in the case of a university excused absence**.

You are encouraged to discuss your homework with classmates; however, you must turn in (and understand) your own solutions. Turning in solutions that are not your own is a violation of department and university academic integrity policies, and violations will be referred to the Honor Council. Additionally, you are not permitted to view homework solutions from the web or from other students who took this course previously (e.g., homework from previous students). Note that any version of the solution manual that is posted online has been posted illegally and that the solution manual contains frequent errors in solutions.

Follow these guidelines for homework assignments:

- Include a cover page with your name, student ID number, date, course number, assignment number and signed honor pledge.
- Write on only one side of the page and include your name and page number.
- Staple the pages together.
- Write out a reasonable amount of step-by-step work to make the problem solving process clear, including but not limited to listing knowns, assumptions, flow diagrams, etc. Graders are not obligated to giving full credit if large gaps are present and the thought process is not clear. In addition, homework should be neatly written or typed. If it is illegible, it will not be graded.
- Homework assignments will be graded partially for completion and partially for accuracy. Problems that are only partially completed or do now show sufficient work will not earn any points.

Reading Assignments

Reading assignments will be included on ELMS. The course will not follow the order of the text, and you will only be responsible for the assigned material. Reading the textbook before class will make lecture much more valuable. On occasion, additional references will be provided.

Quizzes

Five short (20 minute) quizzes will be given in discussion section. Only the highest four quiz scores will be counted towards the final grade. Quiz problems will be based on (but not identical to) homework problems assigned since the last quiz. Quizzes are closed book and closed notes. Relevant equations will be provided by the instructor. Department calculators will be provided if calculations are required. You may also use your own scientific calculator up to TI-36x Pro. In order to receive full credit, students must show all work.

Students will have the opportunity to make up a missed quiz in case of an excused absence (with appropriate documentation). Note that a self-signed sick not is not acceptable for a missed quiz. Students must contact the instructor within 3 business days of the absence to schedule the makeup unless there are extenuating circumstances. For planned absences (ie interview, religious holiday), students should contact the instructor prior to the missed quiz. Students may also elect to use their "drop" for a missed quiz.

Project

All students must complete a semester team project. Project details will be provided after the first exam. The project will be due on Tuesday, December 5th.

Exams

There will be two in-class exams (75 min) and one comprehensive final exam (2 hrs). Exams must be promptly turned in at the end of each class/exam period. For each exam, you may prepare and use one 8½ in. x 11 in. sheet for reference (one side only for semester exams, two sides for the final exam). This reference sheet must be turned in along with your exam and will be returned to you after the exam is graded. Department calculators will be provided if calculations are required. You may also use your own scientific calculator up to TI-36x Pro. No unauthorized materials or tools may be visible during exams, and students must stop working on the exam promptly when informed the exam is over; violation of these policies is a violation of the Code of Academic Integrity.

Exam Dates are as follows. Material covered on the exam will be confirmed 1 week prior to the exam. The exam may be moved to a different room or split into multiple rooms. This will be communicated at least 1 week prior to the exam.

Exam 1: Tuesday, October 3, 2-3:15 pm
Exam 2: Thursday, November 9, 2-3:15 pm
Final Exam: Saturday, December 16, 10:30 am- 12:30 pm

Re-grade Requests

Any questions (or complaints) regarding grading of homework, quizzes or exams must be brought up within one week of the graded item being returned. Requests for reconsideration after this time will not be accepted. Questions (or complaints) regarding homework should be directed to the teaching assistant, quizzes to the undergraduate teaching fellows and those regarding exams should be directed to the instructor.

TOPICS & TENTATIVE COURSE OUTLINE

	Date	Class Type	Topic	Reference Material*	HW Assigned	HW Due	Quiz
L1	29-Aug	Tu Lecture	Course Overview	Chapter 0			
L2	31-Aug	Th Lecture	Hydrostatics	Notes			
D1	1-Sep	Fr Discussion	Special Lecture: Math Review	Notes	HW1	Refl. 1	
L3	5-Sep	Tu Lecture	Surface Tension	Notes			
L4	7-Sep	Th Lecture	Surface Tension	Notes			
D2	8-Sep	Fr Discussion	Review key lecture and HW concepts		HW2	HW1	
L5	12-Sep	Tu Lecture	Momentum Flux Expression	Chapter 1			
L6	14-Sep	Th Lecture	Introduction to shell balances in cartesian coordinates	Chapter 2			
D3	15-Sep	Fr Discussion	**Quiz,** Review key lecture and HW concepts		HW3	HW2	Quiz 1
L7	19-Sep	Tu Lecture	Shell balances in cylindrical coordinates	Chapter 2			
L8	21-Sep	Th Lecture	Shell balances in cylindrical coordinates	Chapter 2			
D4	22-Sep	Fr Discussion	Review key lecture and HW concepts		HW4	HW3	
L9	26-Sep	Tu Lecture	Shell Balance problems	Chapter 2			
L10	28-Sep	Th Lecture	Shell Balance problems/ exam 1 review	Chapter 2			
D5	29-Sep	Fr Discussion	**Quiz,** Review key lecture and HW concepts			HW4	Quiz 2
L11	3-Oct	Tu Lecture	**EXAM 1**				
L12	5-Oct	Th Lecture	Non-newtonian fluids	Chapter 8			
D6	6-Oct	Fr Discussion	Return and review exam 1, introduce project		HW5		
L13	10-Oct	Tu Lecture	Non-newtonian fluids	Chapter 8			
L14	12-Oct	Th Lecture	Introduction to Continuity and NS Equations	Chapter 3			
D7	13-Oct	Fr Discussion	Review key lecture and HW concepts		HW6	HW5, Refl. 2	
L15	17-Oct	Tu Lecture	Application of NS Eqns	Chapter 3			
L16	19-Oct	Th Lecture	Application of NS Eqns	Chapter 3			
D8	20-Oct	Fr Discussion	**Quiz,** Review key lecture and HW concepts		HW7	HW6	Quiz 3
L17	24-Oct	Tu Lecture	Application of NS Eqns	Chapter 3			
L18	26-Oct	Th Lecture	Buckingham Pi Theorem	Chapter 5			
D9	27-Oct	Fr Discussion	Review key lecture and HW concepts		HW8	HW7	
L19	31-Oct	Tu Lecture	Dimensional analysis	Chapter 5			
L20	2-Nov	Th Lecture	Non-dimensionalization in problems	Chapter 5			
D10	3-Nov	Fr Discussion	**Quiz,** Review key lecture and HW concepts			HW8	Quiz 4
L21	7-Nov	Tu Lecture	Friction factors	Chapter 6			
L22	9-Nov	Th Lecture	**EXAM 2**				
D11	10-Nov	Fr Discussion	Special Lecture: Friction Factors	Chapter 6	HW9		
L23	14-Nov	Tu Lecture	Return and review exam 2, Friction Factors	Chapter 6			
L24	16-Nov	Th Lecture	Macroscopic Balances	Chapter 7			
D12	17-Nov	Fr Discussion	Review key lecture and HW concepts		HW10	HW9	
L25	21-Nov	Tu Lecture	Macroscopic Balances	Chapter 7			
	23-Nov	Th Lecture	THANKSGIVING NO CLASS				
	24-Nov	Fr Discussion	THANKSGIVING NO CLASS				
L26	28-Nov	Tu Lecture	Macroscopic Balances	Chapter 7			
L27	30-Nov	Th Lecture	Macroscopic Balances	Chapter 7			
D13	1-Dec	Fr Discussion	**Quiz,** Review key lecture and HW concepts		HW11	HW10	Quiz 5
L28	5-Dec	Tu Lecture	Turbulent Flow **PROJECT DUE**	Chapter 4			
L29	7-Dec	Th Lecture	Turbulent Flow	Chapter 4			
D14	8-Dec	Fr Discussion	Review key lecture and HW concepts			HW11, Refl. 3	
Sat	16-Dec	FINAL	**FINAL EXAM 10:30 am- 12:30 pm**				
	* Exact reading assignments will be provided on ELMS.						