SYLLABUS
155:303: TRANSPORT IN CHEMICAL ENGINEERING I: FLUID MECHANICS PHENOMENA

FALL 2017

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155: 303 Transport Phenomena I: Fluid Mechanics Fall 2017

Lectures: Tue, Thu 1:40PM to-3:00pm, Fiber Optics
Instructor: M. Silvina Tomassone
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Office Hours: Tuesdays from 3:00PM to 4:00PM – Thursdays from 3:00PM to 4:00pm.
Or by appointment.
Teaching Assistant: Adam Zuber - Office hours: Mondays and Wednesdays from 12pm to 1:30PM

Course Description: The course is an introductory presentation of the basic fundamental principles of Momentum transport, which is the subject of a branch of the physical sciences known as "Fluid Mechanics" and focuses on the forces that act on fluids in motion. The course will begin with a brief review of hydrostatics, followed by a detailed study of the fundamental conservation laws governing fluid mechanics. After a series of simple examples illustrating the use of these principles, we will focus on more complex cases: potential flows, turbulence, non-Newtonian fluids, boundary layer. The focus of the course will then shift to engineering approaches: transport coefficients and macroscopic balances. This material will be illustrated with examples from the most common technology: pumps, valves, tanks, head meters, etc.

Course Objectives:
(1) To provide an introduction to fluid mechanics as a fundamental component of chemical engineering science.
(2) To develop physical intuition and problem-solving skills.
(3) To lay the foundation for studies on heat and mass transfer.
The material covered in this course is required knowledge for mass transfer, heat transfer, reaction engineering, design, and control. We will be covering a lot of material in detail. Be prepared to work, hard and consistently.

Textbooks:
Required: "Fluid Mechanics" 8th Edition- by Frank White
This is an introductory book with many interesting examples.

Recommended additional reading: Basic Fluid Mechanics" by David C. Wilcox;
"Transport Phenomena" by Bird, Stewart, and Lightfoot
This is the classic textbook in transport phenomena and every chemical engineer should be familiar with it.

Occasionally, there will be additional reading assignments from other books:
(1) "Fluid Mechanics for Chemical Engineers", by James O. Wilkes.
(2) "Fundamentals of Momentum, Heat, and Mass Transfer" by Welty, Wicks, and Wilsons
(3) "An Introduction to Fluid Mechanics" by Stanley Middlemann
Several copies of each of these texts have been placed on reserve in SEC.

Software:
Matlab: This is an interactive environment for system simulations. It is installed on all PCs in the Microcomputer Lab (room C233).

Assessment:
Homework 10%
Quizzes 10%
Final Written Report / Oral Presentation 10%
Midterm 30%
Final 40%

Course Contents

Week	Lecture	Date	Topic	Chapter
1	1	Sep. 5	Course Organization-Introduction to Fluids –Concept of a Fluid – Fluid Properties - Velocity Fields- Pressure Acceleration- Continuum Hypothesis	1
	2	Sep. 7 Hw1	Mass Flow Rate- Volume Flow Rate- Surface Fluxes- Eulerian and Lagrangian approaches-– Viscosity – Reynolds Number- Non Newtonian Fluids	1
2	3	Sep. 12	Viscosity- Thermal Conductivity- Surface Tension Streamlines – Streaklines – Pathlines- Examples.	1
	4	Sep. 14 Hw2	Hydrostatics- Pressure Distribution in a Fluid Pressure Distribution in a Fluid – Examples –	2
3	5	Sep. 19	Hydrostatics Continuation- Forces on submerged objects.	2
	6	Sep. 21 Hw3	Control Volume Approach- Surface Fluxes Reynolds Transport Theorem.	3
4	7	Sep. 26	Reynolds Transport Theorem – Examples	3
	8	Sep. 28 Hw4	Conservation of Momentum –Euler's Equation– Bernoulli Equations-	3
5	9	Oct 3	Angular Momentum Conservation with control volume approach	3
	10	Oct. 5 Hw5	Examples	4
6	11	Oct. 10	Differential Relations of Fluid Flow – Mass Conservation and Momentum Conservation- Navier Stokes	4
	12	Oct. 12	Boundary Conditions- Examples.	4

		Hw6		
7	13	Oct. 17	Examples Navier Stokes.	4
	14	Oct. 19	Review	
8		Oct. 24	**MIDTERM I**	
	15	Oct 26	Flow in Pipes and Ducts Laminar Flow - Piping and pumping problems -	6
9	16	Oct 31	Friction factors - Major and Minor Losses – Fittings- Examples	6
	17	Nov 2 Hw7	Turbulent Flow	6
10	18	Nov. 7	Dimensionless Equation of Motion- Dimensionless Numbers	5
	19	Nov. 9 Hw8	Dimensional Analysis – Non -Dimensional equations	5
11	20	Nov. 14	Boundary Layer Theory Momentum Integral equations Boundary Layer Equations – Prandtl Solution	5
	21	Nov. 16 Hw9	Boundary Layer Karman's Analysis of Flat Plate with a with a Pressure Gradient	7
12	22	Nov. 21	Example Problems of Boundary Layer	7
		Nov. 24	**Thanksgiving Break**	
13	23	Nov. 28 Hw10	Boundary Layer – Lift	7
	24	Nov 30	Review Part II	1-2-3-4
14	25	Dec. 5	Review Part I	5-6-7
		Dec. 7	Oral Presentations	
15		Dec 12	Oral Presentations	
		TBD	**Final Exam**	