

CHEE 2110 – PROCESS FLUID MECHANICS Spring 2016

Course Description: Understanding the concept of fluid mechanics and its application to chemical processes: i) The quantitative description of momentum transfer. ii) Application of engineering principles and methods to modeling and quantifying chemical systems for system design and operation. iii) Mathematical approach to fluid processes using momentum balance equations and computer software.

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Lecture: MWF 11:00-11:50 AM, PL3070
Office Hours: Monday and Wednesday 2 – 4 pm and by appointment.

TA: Surachet “Ray” Duanghathaipornsuk (Surachet.Duanghathaipornsuk@rockets.utoledo.edu)
Office Hours: Mon 1 to 3 pm and Wed 3 to 5 pm at the student lounge on the third floor (NI)

Required Text: Unit Operations of Chemical Engineering (Smith and Harriott, 7th ed., McGraw-Hill, 2004)

Recommended Text: Fluid Mechanics for Chemical Engineers (J.O. Wilkes, 1st ed., Prentice Hall, 1999)
Process Fluid Mechanics (M.M. Denn, Prentice Hall, 1980)
Fundamentals of Momentum, Heat and Mass Transfer (Welty, Wicks and Wilson, 3rd ed., John Wiley and Sons, 1984)
Transport Phenomena (Bird, Stewart, and Lightfoot, John Wiley & Sons, 1960)

Course Objectives:

Outcome a: an ability to apply knowledge of mathematics, science, and engineering

Outcome e: an ability to identify, formulate, and solve engineering problems

- Students will be able to explain the basic laws of momentum transfer, and their application to chemical engineering systems. (*Outcome a: HW problems, exam problems, example problems in class*)
- Students will be able to formulate models and solve engineering problems related to momentum transport and to apply these calculations to chemical engineering systems. (*Outcome e: HW problems, exam problems, example problems in class*)
- Students will be able to use computational tools (EXCEL and Polymath) as necessary to solve engineering problems. (*Outcome k; HW problems, example problems in class*)
- Students will be able to synthesize what they have learned and apply their knowledge to unfamiliar systems in chemical engineering processes. (*Outcomes a & e: HW problems, exam problems*)

Grading: Homework: 15%
Midterm I: 25%
Midterm II: 25%
Final Exam (10:15 am -12:15 pm, May 6, Friday): 35%

Homework policy: Homework is due one week after assignment. No late homework will be accepted.

Grade points: 100-90: A, 89-87: A-, 86-84: B+, 83-81: B, 80-78: B-, 77-75: C+, 74-72: C, 71-69: C-, 68-66: D+, 65-63: D, 62-60: D-, 59-0: F

Detailed Course Objectives

Week	Date	Topic	Assignment
1	Jan 11, 2016 (Mon)	I. Introduction – Fluid mechanics in unit operations	
	Jan 13, 2016 (Wed)	Units, notations, and significance figures	
	Jan 15, 2016 (Fri)	Hydrostatics - I	HW1
2	Jan 18, 2016 (Mon)	Martin Luther King Day	
	Jan 20, 2016 (Wed)	Hydrostatics - II	
	Jan 22, 2016 (Fri)	Hydrostatics - III	
3	Jan 25, 2016 (Mon)	Buoyancy, absolute pressure, gauge pressure	HW2
	Jan 27, 2016 (Wed)	II. Fluid Flow Phenomena - Viscosity	
	Jan 29, 2016 (Fri)	Viscosity of liquids and gases	
4	Feb 1, 2016 (Mon)	Molecular theory of viscosity	HW3
	Feb 3, 2016 (Wed)	Newtonian fluid	
	Feb 5, 2016 (Fri)	Non-Newtonian fluid	
5	Feb 8, 2016 (Mon)	Viscosity measurement	
	Feb 10, 2016 (Wed)	Boundary layer	HW4
	Feb 12, 2016 (Fri)	III. Incompressible Flow in Pipes and Channels Introduction Dimensional analysis	
6	Feb 15, 2016 (Mon)	Buckingham pi theorem	
	Feb 17, 2016 (Wed)	Friction factor	HW5
	Feb 19, 2016 (Fri)	Friction factor-Reynolds number data	
7	Feb 22, 2016 (Mon)	Example problems	
	Feb 24, 2016 (Wed)	Power input and dissipation	HW6
	Feb 26, 2016 (Fri)	Midterm I	
8	Feb 29, 2016 (Mon)	Flow through a circular tube Shell momentum balance	
	Mar 2, 2016 (Wed)	Example problems	
	Mar 4, 2016 (Fri)	Piping problems - case 1	
9	Mar 7 - 11, 2016	Spring Break	
10	Mar 14, 2016 (Mon)	Laminar flow between two parallel plates	
	Mar 16, 2016 (Wed)	Flow types - Summary	
	Mar 18, 2016 (Fri)	Bernoulli equation	
11	Mar 21, 2016 (Mon)	Pump work in Bernoulli equation	HW8
	Mar 23, 2016 (Wed)	Pump power calculation in flow system - 1	
	Mar 25, 2016 (Fri)	Pump power calculation in flow system - 2	
12	Mar 28, 2016 (Mon)	Friction losses and mechanical energy balance	
	Mar 30, 2016 (Wed)	Midterm II	
	Apr 1, 2016 (Fri)	IV. Flow Past Immersed Bodies Drag Drag Coefficient	
13	Apr 4, 2016 (Mon)	C_D and Re	
	Apr 6, 2016 (Wed)	Flow through beds of solids	HW7
	Apr 8, 2016 (Fri)	Two models	
14	Apr 11, 2016 (Mon)	Ergun equation	
	Apr 13, 2016 (Wed)	Fluidized bed	HW8
	Apr 15, 2016 (Fri)	V. Transportation and Metering	
15	Apr 18, 2016 (Mon)	Valves	
	Apr 20, 2016 (Wed)	Pumps	
	Apr 22, 2016 (Fri)	Head-work relation in an ideal pump	
16	Apr 25, 2016 (Mon)	Measurement of fluids - Venturi meter	
	Apr 27, 2016 (Wed)	Orifice meter	HW9
	Apr 29, 2016 (Fri)	Other devices	
17	May 6, 2016 (Fri)	Final Exam 10:15 AM -12:15 PM (2 hours)	Good luck