14:155:304 TRANSPORT II: MASS & HEAT TRANSPORT Spring 2018

Department of Chemical and Biochemical Engineering, Rutgers University

Course Instructor: **Professor Nina Shapley**

Course Schedule: **Monday & Wednesday, 1:40 – 3:00 PM, Pharmacy 115**

Instructor Office Hours: Engineering C-230; Monday, 3:00-4:30 PM or by appointment
Instructor Contact: nshapley@soe.rutgers.edu OR ncs2101@gmail.com

Teaching Assistants: Jinwoong Nam
Email address: jn494@scarletmail.rutgers.edu
TA Office Hours and Location: Engineering C-254; Tuesday, 2:00-3:30 PM.

Learning Assistants: Travis Cote and Shoaib Mehkri
Study Group Hours and Location: (1) Tuesday, 3:20 pm - 4:40 pm, SERC 104 (Travis); (2) Wednesday, 3:20 pm – 4:40 pm, ARC 203 (Travis); (3) Thursday, 5:00 pm - 6:20 pm, SERC 104 (Shoaib).

Course Website: sakai.rutgers.edu

Course Description in Key Words:
Energy and mass transfer in chemical engineering processes. Steady-state and unsteady-state heat conduction and molecular diffusion. Energy and mass transfer in fluids undergoing flow, phase change and/or chemical reaction. Radiant heat transfer, heat exchangers and mass transfer equipment.

Course Objectives:
Equip each student with necessary analytical understanding and quantitative tools to address the following questions:

- How can physical phenomena be represented mathematically? How does one construct simple mathematical models to capture transport processes?
- What are the various modes of chemical/molecular mass transport and how does one "model" their contributions toward transport dynamics in situations relevant to chemical engineering, broadly defined?
- What are the elements of phenomenological/lumped-parameter and mechanistic approaches to describe transport, and when is either applicable?
- What are the basic formulations for solving steady state, quasi-steady state, and unsteady state (transient) mass transfer problems?
- In which problems do diffusive and convective transport interact, and what are the theories to formulate and solve these problems?
- What are the basic modes of heat transfer?
- How can heat exchangers be designed for specific processes?

Main textbook: Fundamentals of Momentum, Heat, and Mass Transfer (5th edition)
by James R. Welty, Charles E. Wicks, Robert E. Wilson and Gregory L. Rorrer, John Wiley & Sons, 2008.

Alternate textbook: Introduction to Mass and Heat Transfer, Principles of Analysis and Design
by Stanley Middleman, John Wiley & Sons, 1998.

Lecture Schedule: **Mondays & Wednesdays, 1:40 – 3:00 PM, Pharmacy 115**

1	1/17 Wed.	Introduction to Diffusion and Convection; Fick's Law of Diffusion
2	1/22 Mon.	Examples of Diffusive Transport
3	1/24 Wed.	Generalized Mass Balances
4	1/29 Mon.	Examples of Steady State and Pseudo-Steady State Transport
5	1/31 Wed.	Diffusion in Rectilinear Coordinates
6	2/5 Mon.	Diffusion in Non-Rectilinear Coordinates
7	2/7 Wed.	Diffusion and Homogeneous Reaction
8	2/12 Mon.	Diffusion and Homogeneous Reaction Continued
9	2/14 Wed.	Additional Diffusion and Reaction Examples; Non-Rectilinear Coordinates
10	2/19 Mon.	***Quiz 1***; Diffusion and Convection
11	2/21 Wed.	Diffusion and Convection Continued
12	2/26 Mon.	Diffusion and Heterogeneous Reaction
13	2/28 Wed.	Unsteady State Diffusion; Diffusion into Semi-Infinite Media
14	3/5 Mon.	Midterm Review
15	**3/7 Wed.**	**SNOW DAY**
		** *Spring Break* **
16	3/19 Mon.	Convective Mass Transfer
17	**3/21 Wed.**	**SNOW DAY**
18	**3/26 Mon.**	**Midterm Exam**
19	3/28 Wed.	Convective Mass Transfer
20	4/2 Mon.	Convective Mass Transfer Coefficients
21	4/4 Wed.	Film and Boundary Layer Theories
22	4/9 Mon.	Introduction to Heat Transfer by Conduction
23	4/11 Wed.	Heat Conduction Problems
24	4/16 Mon.	Transient Heat Conduction
25	4/18 Wed.	***Quiz 2***; Convective Heat Transport
26	4/23 Mon.	Design of Heat Exchangers
27	4/25 Wed.	Design of Heat Exchangers Continued; Final Exam Review
28	4/30 Mon.	In class presentations/discussions; ***Presentation slides due by email***
29	**5/8 Tues. 12-3 PM**	**FINAL EXAM**

Grading Structure:
25% Midterm Exam; 30% Final Exam;
10% Quizzes;

20% Homework Solutions;
15% Research Project (Presentation and in-class discussion);
and Class Participation.

ABET Outcomes and Assessment:

Program outcomes achieved in this course (bolded)

(a) an ability to apply knowledge of mathematics, science and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) an ability to design a system, component, or process to meet desired needs
(d) an ability to function in multi-disciplinary/multi-functional teams (this can be defined as a mix of biochemical and chemical engineers, or as a group of students working on a different roles of a project)
(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibilities.
(g) an ability to communicate effectively
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

The achievement of outcome (e) will be assessed in this course as follows:

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

Homework and exam problems that will require the students to identify the engineering approach/problem within the topic identified, and to formulate and review solution strategies.

Academic Integrity:
Students are expected to read and follow the Rutgers University policy on academic integrity, discussed at the following two links:
http://academicintegrity.rutgers.edu/academic-integrity-policy/
http://academicintegrity.rutgers.edu/academic-integrity-at-rutgers

This course has specific expectations for the set of assignments given during the semester:

- Discussion of homework problems is encouraged, but everyone must write up and turn in his/her own work.
- The exams and quizzes in this course are tests of individual performance. The student is not permitted to obtain assistance from any other person (or persons) during exams. The exams and quizzes in this course will be closed book and closed notes, with the exception of a one-page (8.5" x 11") formula sheet (both sides). Use of non-graphing calculators is allowed. Use of laptops, phones, iPads or graphing calculators is not allowed.

Disciplinary actions for academic misconduct will be in accord with the University policy on academic integrity.