14:155:304 TRANSPORT II: MASS & HEAT TRANSPORT Spring 2025

Department of Chemical and Biochemical Engineering, Rutgers University

Course Instructor: **Professor Henrik Pedersen**

Course Schedule: **Tuesday & Thursday, 2:00 – 3:20 pm, ARC 105**

Instructor Office Hours: Wednesday, 1:00-2:00 PM by appointment, Engineering C-005A
Instructor Contact: via Canvas interface only

Teaching Assistant:
Email address:
TA Office Hours and Location:

Learning Assistant: Yiwei Shao
Email address: ys735@scarletmail.rutgers.edu
Study Group Hours and Locations: SG: 01: Tuesday, 5:40pm – 7:00pm, SERC 104 (Busch Learning Center); SG: 02: Thursday, 5:40pm - 7:00pm, Online
First meeting: 3rd week of classes, Tuesday Feb. 4

Course Website: **canvas.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. Heat exchangers and mass transfer equipment.

Course Objectives:

Equip each student with 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 heat and mass 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) heat and 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 and separation equipment be designed for specific processes?

Required textbook: Fundamentals of Momentum, Heat, and Mass Transfer (**7th edition**) by James R. Welty, Gregory L. Rorrer, and David G. Foster, John Wiley & Sons, 2019. https://www.wiley.com. It is recommended to utilize the E-Book version as a 180-day rental. The Rutgers bookstore also has links to access this text.

Schedule: Tuesday & Thursday (TTh4), 2:00 – 3:20 PM, ARC 105

1	1/21 Tues	Course introduction and the development of the Macroscopic Energy Balance	Chap. 6
2	1/23 Thurs.	Problem solving techniques and expectations	Chap. 6
3	1/28 Tues	Local forms of the energy balance and incorporation of constitutive equations	Chap. 15, 16
4	1/30 Thurs.	Energy transport by convection and combined mechanisms of conduction, convection and radiation	Chap. 15
5	2/04 Tues	Examples of steady state heat transfer	Chap. 17.1-2
6	2/06 Thurs.	Fins and extended surfaces	Chap. 17.3
7	2/11 Tues	Techniques for solving temperature profiles in multi-dimensional systems	Chap. 17.4
8	2/13 Thurs.	Examples of unsteady state heat transfer	Chap. 18
9	2/18 Tues	Integral analysis of unsteady heat transfer	Chap. 18
10	2/20 Thurs.	Convective heat transfer	Chap. 19
11	**2/25 Tues**	**Quiz 1; Energy transfer**	**Chap. 15-18**
12	2/27 Thurs.	Convective heat transfer correlations	Chap.20
13	3/04 Tues	Design of heat transfer equipment	Chap. 22
14	3/06 Thurs.	Examples	Chap. 15-20,22
15	3/11 Tues.	Review and practice problems	Chap. 15-20,22
16	**3/13 Thurs.**	**Midterm Exam**	**Chap. 15-20,22**
	3/15-3/23	** *Spring Break* **	

17	3/25	Tues.	Macroscopic and local forms of the species mass balance	Chap. 25
18	3/27	Thurs.	Steady state mass transfer without reaction	Chap. 26
19	4/01	Tues.	Mass transfer in reactive systems with simultaneous heat and momentum transfer	Chap. 26
20	4/03	Thurs.	Examples and problem solving for steady state systems	Chap. 26
21	4/08	Tues.	Unsteady state mass transfer	Chap. 27
22	4/10	Thurs.	Charts and numerical strategies for solution of unsteady transport problems	Chap. 27, Appendix F
23	4/15	Tues.	Convective mass transfer	Chap. 28
24	4/17	Thurs.	Convective mass transfer correlations and integral analysis. Momentum, heat and mass transfer analogies	Chap. 28
25	4/22	Tues.	Mass transport with phase changes. Typical interfacial conditions	Chap. 29
26	**4/24**	**Thurs.**	**Quiz 2; Mass transfer**	**Chap. 25-28**
27	4/29	Tues.	Design of mass transfer equipment	Chap. 31
28	5/01	Thurs.	Review and exam preparation	Chaps 25-31
29	**5/13**	**Tues.**	**Final Exam, 12 noon – 3 pm**	**Chap. 25-31**

Grading Structure:

- 30% Homeworks (around 10)
- 20% Quizzes (2);
- 25% Midterm Exam (primarily heat transfer);
- 25% Final Exam (primarily mass transfer).

General Expectations

- ***Students will attend and participate in class lectures.***
- ***All communications and submissions will utilize the Canvas interface.***
- ***Examples in class will provide the template for solution of homework problems.***
- ***HW solutions will be promptly provided—late HWs will not be accepted.***
- ***Usual allowances for acommodations will be done provided the instructor is contacted ahead of time.***
- ***See also Academic Integrity below.***

ABET Outcomes and Assessment:

(for CBE internal use)

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

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 their 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 calculators is allowed. Use of laptops, phones, iPads or internet-connected devices is not allowed.

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