Chemical and Biochemical Engineering 16:155:501
Advanced Transport Phenomena I
Fall 2015
Instructor: Nina Shapley

Syllabus

Introduction
Advanced Transport Phenomena I is a course that focuses on multiple aspects of momentum transfer, or fluid mechanics. The class begins at a fundamental level, focusing on the question of how a system with initially nonuniform temperature, concentration, or velocity changes in space and time. We will derive the equation for conservation of momentum and apply it in many model situations. However, transport is also a subject with many practical applications (*biomedical*—drug delivery, dialysis, bioreactors; *industrial*—heat exchangers, materials processing, packed bed/fluidized bed reactions, oil drilling/recovery; *environmental*; *meteorological*, etc.), so it's an important step along the way for many different directions you can take in chemical engineering.

Schedule of lectures

Tues. 5:00 – 8:00 PM, BME 102 (BME Auditorium)

9/1	Introduction to course. Molecular basis of transport phenomena and Newton's law of viscosity (*Chap. 1, Deen 1st & 2nd ed.; Chap. 1, BSL)* Review of basic vector calculus for vectors and tensors (*Appendix A, all*)
(9/8)	***No class (Monday class schedule).***
9/15	Conservation equations (bulk) in integral and differential form Conservation equations (interfacial) in integral and differential form (*Chap. 2: 1st & 2nd ed.; Chap. 3, BSL*)
9/18	Make-up class. Fluid mechanics (conservation of momentum equation, definitions, boundary conditions) (*Chap. 5, 1st ed.; Chap. 6, 2nd ed.; Chap. 3, BSL*)
(9/22)	***No class (religious holiday, replaced by 9/18 class).***
9/29	Unidirectional flow (wall-driven and pressure-driven flow) (*Chap. 6, 1st ed.; Chap. 7, 2nd ed.; Chap. 2&3, BSL*) Lubrication flow (*Chap. 6, 1st ed.; Chap. 7, 2nd ed.; Chap. 2, BSL*)
10/6	Dimensional analysis (orders of magnitude, symmetry, dynamic similarity) (*Chap. 3 & 5, 1st ed.; Chap. 3 & 6, 2nd ed.; Chap. 3, BSL*)
(10/13)	***No class (conference).***

10/20	2D transport problems (separation of variables) (*Chap. 4, 1st ed.; Chap. 5, 2nd ed.; Chap. 4, BSL*) 2D flow problems (*Chap. 6, 1st ed.; Chap. 7, 2nd ed.; Chap. 4, BSL*)
10/27	**Test, in class.**
11/3	Time-dependent flows (*Chap. 3 & 6, 1st ed.; Chap. 3, 4, 7, 2nd ed.; Chap. 4, BSL*) Vorticity equation and stream function (*Chap. 5, 1st ed.; Chap. 6, 2nd ed.; Chap. 4, BSL*)
11/10	Creeping flow (*Chap. 7, 1st ed.; Chap. 8, 2nd ed.; Chap. 4, BSL*) Stream function solutions of axisymmetric problems (flow around a sphere) (*Chap. 7, 1st ed.; Chap. 8, 2nd ed.; Chap. 4, BSL*)
11/17	Inviscid flow (*Chap. 8, 1st ed.; Chap. 9, 2nd ed.; Chap. 4, BSL*) Potential flow (*Chap. 8, 1st ed.; Chap. 9, 2nd ed.; Chap. 4, BSL*)
11/24	Boundary-layer theory (*Chap. 8, 1st ed.; Chap. 9, 2nd ed.; Chap. 4, BSL*)
12/1	Non-Newtonian fluids (*Chap. 5, 1st ed.; Chap. 6, 2nd ed.; Chap. 8, BSL*)
12/8	Introduction to turbulence (time-averaged equation of motion) (*Chap. 13, 1st & 2nd ed.; Chap. 5, BSL*) Review for final exam

Text

Main text:

William M. Deen, *Analysis of Transport Phenomena, 1st or 2nd edition,*
Oxford University Press, New York, 1998 or 2012.

Other recommended text:

R. Byron Bird, Warren E. Stewart and Edwin N. Lightfoot ("BSL"),
Transport Phenomena, 2nd Edition
John Wiley & Sons, Inc., 2002.

Course website

https://sakai.rutgers.edu/portal
Course website name: ADV TRANSPORT PHEN I 01 F15

Contact information

Instructor: Nina Shapley
Engineering Building C-230
phone: (848) 445-4951
e mail: nshapley@rci.rutgers.edu OR ncs2101@gmail.com

TA: Tao Zhang
e mail: tz87@scarletmail.rutgers.edu

Office hours
Wednesday, 12-1 PM, or by appointment; Engineering Building C-230

Homework
Homework will typically be due 1-2 weeks after it is handed out in class.
Solutions will be available on the day the assignment is turned in. For this reason, late homework will not be accepted. However, if you are worried about making the deadline in a particular week, or there are special circumstances, please come see me in advance and we'll make an arrangement.

Discussion of the homework problems is encouraged, but everyone must write up and turn in his/her own work.

Exams
1 midterm, 1 final.
Midterm exam: 10/27 (in class), tentative date.
Final exam: During week of 12/15-12/22: TBA. (Default option is during class time on Tuesday, 12/15.)

Group Project: Critique of journal article
Students will be assigned to groups of four. Each group will select a journal article from a provided list of articles related to fluid mechanics. The group will write and present a brief (~10 minute) PowerPoint presentation describing the major results of the paper, the relevance to the course material and a technical critique of the research. Presentations will occur throughout the last 6-7 weeks of the course. A more detailed assignment will be provided early in the course, including periodic deadlines.

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/policy-on-academic-integrity
http://academicintegrity.rutgers.edu/academic-integrity-at-rutgers

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

- As mentioned above, discussion of homework problems is encouraged, but everyone must write up and turn in his/her own work.
- The exams 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 in this course will be open book, and open notes. Use of calculators is allowed. Use of computers, laptops to access e-books only is allowed.

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

Grading
Tentative breakdown: 15% homework, 30% midterm, 40% final, 15% group project.