BE435 TRANSPORT PHENOMENA IN LIVING SYSTEMS (Fall 2022)

The transport of heat and molecules underlies numerous important applications in biomedical engineering. A strong understanding of transport phenomena is crucial to fields as diverse as drug delivery, forensics, tissue engineering, non-invasive imaging, and the development of artificial organs. This course focuses on the fundamental concepts and equations that govern heat and mass transfer, mathematical methods for solving transport problems, and ways of relating complex problems to simpler ones that illustrate key principles.

Course info: The class meets at 9-10:45 AM on Tuesdays and Thursdays in CAS 211. Prerequisites for this class are ordinary differential equations (MA226) and first-year physics (PY212).

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Textbooks (*recommended*):

Incropera et al., *Fundamentals of Heat and Mass Transfer*
We will examine the roles of diffusion, reaction, and convection in heat and mass transfer. This material corresponds roughly to Chapters 1-6, 8, and 14 in the 7th edition.

Johnson and Ethier, *Problems for Biomedical Fluid Mechanics and Transport Phenomena*
This book is an excellent source of extra problems that are similar to our homework.

Various documents on the BE435 Learn website (http://learn.bu.edu)

Bird, Stewart, and Lightfoot, *Transport Phenomena* (a classic)
Deen, *Analysis of Transport Phenomena*
Datta, *Biological and Bioenvironmental Heat and Mass Transfer* (succinct)
Fournier, *Basic Transport Phenomena in Biomedical Engineering*
Truskey, Yuan, and Katz, *Transport Phenomena in Biological Systems* (lots of typos)
Cussler, *Diffusion: Mass Transfer in Fluid Systems*
Berg, *Random Walks in Biology* (good intro to concepts)
Weiss, *Cellular Biophysics, vol. 1*

Grading: Final exam 40%
Midterm 35%

Both exams are cumulative. The final exam will emphasize material covered after the midterm.

Homework 25%

Problem sets will be due on Thursday at 12 PM using Gradescope. **Late homework will not be accepted.** You are expected to work on the assignments individually, except for selected problems where teamwork is allowed and encouraged.

Please note that the grading proportions may change substantially during the semester, especially given the uncertainty associated with Covid-19.

My philosophy on grading:

A = You could be a grader next year
B = You have a solid understanding of the material
C = You can solve simple problems
D = You try hard
F = …

Plagiarism will result in automatic failure in accordance with BU policy.

BE435 TIMELINE

Dates		Topics	Reading
Sep	6	Introduction	Ch. 1
	8	Fick's 1st Law; Fourier's Law	Ch. 2 and 14.1
	13	Diffusion equations	
	15	Diffusion equations (cont'd)	
	20	Steady-state diffusion (planar)	Ch. 3
	22	Steady-state diffusion (planar, cont'd)	
	27	Steady-state diffusion (radial)	
	29	"Ask a Stupid Question" Day	
Oct	4	Steady-state diffusion (radial, cont'd)	
	6	Diffusion with reactions	Rest of Ch. 14
	11	*NO CLASS*	
	13	Diffusion with reactions (cont'd)	
	18	Review	
	20	**MIDTERM**	
	25	Oxygen transport	
	27	Oxygen transport (cont'd)	
Nov	1	Unsteady diffusion (semi-infinite approximation)	Ch. 5.1-5.9
	3	Unsteady diffusion (semi-infinite approximation, cont'd)	
	8	Unsteady diffusion (separation of variables)	
	10	Unsteady diffusion (separation of variables, cont'd)	
	15	Unsteady diffusion with reactions	
	17	Drug delivery	
	22	Linearity in transport problems	
	24	*NO CLASS*	
	29	Scaling analysis	
Dec	1	Scaling analysis (cont'd)	
	6	Convection	Ch. 6
	8	Review	
TBA		**FINAL EXAM (TBA)**	