BioE 104: Biotransport

Instructor: Anand Subramaniam, PhD

Catalog Description: Biological Transport Phenomena is the quantitative description of momentum transport (viscous flow) and mass transport (convection and diffusion) in living systems. We explore the similarities between the fundamental principles of momentum, heat, and mass transfer, and combine fundamentals with conservation laws to develop mathematical descriptions of physiological and engineering systems.

Course Objectives: This course presents, through bi-weekly classes, an opportunity for students to explore a variety of techniques for applying conservation equations of mass and momentum to living and non-living systems and using advanced mathematical techniques for solving such problems. As such, this course addresses certain ABET outcome criteria at a variety of levels.

Specific Outcomes: By the end of the course, students should be able to:

1. Understand conservation of mass, momentum, and energy as applied to the flow of mass and fluids.
2. Use control-volume analysis to formulate governing equations for simple flow and mass transport geometries.
3. Analyze complex fluid flows via approximate analytical tools.
4. Derive appropriate conservation equations, select boundary conditions, and apply analytical and computational techniques to solve flow and mass transfer problems in biological and medical systems.
5. Estimate fluid behavior in compliant structures and u20teady flows.
6. Specify characteristics of fluid and mass transport components in bio/medical systems.

Outcomes Addressed by this Course:

A. An ability to apply knowledge of mathematics, science, and engineering.

E. An ability to identify, formulate, and solve engineering problems.

L. An understanding of biology and physiology.

M. The capability to apply advanced mathematics (including differential equations and statistics), science, and engineering to solve the problems at the interface of engineering and biology.

Prerequisites:

1. BIO 002: Introduction to Molecular Biology
2. MATH 024: Linear Algebra and Differential Equations

3. PHYS 009: Introductory Physics II for Physical Sciences or PHYS 009H: Honors Introductory Physics II for Physical Sciences or PHYS 019: Introductory Physics II for Biological Sciences

Course Policies:

Academic Dishonesty Statement:

a. Each student in this course is expected to abide by the University of California, Merced's Academic Honesty Policy. Any work submitted by a student in this course for academic credit will be the student's own work.
b. You will gain the most from this class if you come prepared. Please do the readings prior to class and participate actively in class discussions.
c. You are encouraged to study together and to discuss information and concepts covered in lecture and the sections with other students. You can give "consulting" help to or receive "consulting" help from such students. However, this permissible cooperation should never involve one student having possession of a copy of all or part of work done by someone else, in the form of an e mail, an e mail attachment file, a diskette, or a hard copy. Should copying occur, both the student who copied work from another student and the student who gave material to be copied will both automatically receive a zero for the assignment. Penalty for violation of this Policy can also be extended to include failure of the course and University disciplinary action.
d. During examinations, you must do your own work. Talking or discussion is not permitted during the examinations, nor may you compare papers, copy from others, or collaborate in any way. Any collaborative behavior during the examinations will result in failure of the exam, and may lead to failure of the course and University disciplinary action.

Disability Statement:

Accommodations for Students with Disabilities: The University of California Merced is committed to ensuring equal academic opportunities and inclusion for students with disabilities based on the principles of independent living, accessible universal design and diversity. I am available to discuss appropriate academic accommodations that may be required for student with disabilities. Requests for academic accommodations are to be made during the first three weeks of the semester, except for unusual circumstances. Students are encouraged to register with Disability Services Center to verify their eligibility for appropriate accommodations.

Textbooks:

Transport Phenomena in Biological Systems (2nd Edition)**,** George A. Truskey, Fan Yuan, David F. Katz. Pearson

Topics:

	Day		**Chapter from Truskey**	**HW**
Week 1	August 23	Introduction; The role of transport processes in biological systems	1.1-1.2	
Week 2	August 28	Definition of transport processes	1.2-1.3	PS 1
	August 30	Math Review	Appendix A.1	
Week 3	September 4	Labor Day		
	September 6	Conservation laws-Continuity	A.3.A. – A.3.C, 2.1-2.2	
Week 4	September 11	Conservation Relations and Boundary Conditions	2.3, A.3.D	
	September 13	Fluid Statics	2.4	PS 1 due, PS 2
Week 5	September 18	Constitutive Relations, Laminar and Turbulent Flow	2.5-2.6	
	September 20	Application of momentum balances	2.7.1-2.7.2	
Week 6	September 25	Application of momentum balances	2.7.3-2.7.5	
	September 27	**Review**		PS 2 due
Week 7	October 2	**Midterm 1**	Chap 1-Chap 2	
	October 4	Introduction, Differential form of the conservation of mass	3.1-3.2	PS 3
Week 8	October 9	Differential form of the conservation of linear momentum and Navier-Stokes	3.3.1	
	October 11	Differential form of the conservation of linear momentum and Navier-Stokes	3.3.2	
Week 9	October 16	Fluid motion with more than one dependent variable	3.4	
	October 18	Dimensionless Analysis and Dimensionless Groups	3.5	

Week 10	October 23	Low Reynolds number Flow	3.6	
	October 25	**Review**		PS 3 due
	October 30	**Midterm 2**		
	Nov 1	Fick's First Law, Steady State Diffusion in One Dimensions	6.4.1,6.7.1	Self-Study (6.1-6.2), PS 4 assigned
Week 11	Nov 6	Steady State Diffusion	6.7.2,6.7.3	
	Nov 8	Unsteady Diffusion	6.8.1	
Week 12	Nov 13	Unsteady Diffusion	6.8.2	
	Nov 15	Quasi-Steady Transport Across Membranes	6.8.4	
Week 13	Nov 20	Fick's Law of Diffusion and Solute Flux, Conservation of Mass for Dilute Solutions	7.1-7.2	
	Nov 22	Non Instructional Day		
Week 14	Nov 27	Dimensional Analysis, Diffusion and Convection	7.4, 7.6	PS 4 due, Self-Study (7.7, 7.8)
	Nov 29	Mass Transfer Coefficients	7.9	
Week 15	December 4	Mass Transfer Coefficients	7.9	
	December 6	Review		
	December 9	Final Exam		

Class Schedule: Monday, Wednesday, 10:30-12:20 am. COB1- 267

Assessment/Grading Policy:

- 20% Homework (4 problem sets total)
- 20% Midterm#1 (in-class 90 minute exam)
- 20% Midterm#2 (in-class 90 minute exam)
- 30% Final Exam (in-class 90 minute exam)
- 10% Attendance, in-class participation, in class quizzes

All exams are closed book. No makeup midterm exams will be given. Final exam grade may be substituted for one midterm if your final grade is higher.

Homework: Problem sets are due in class at the end of class of the due date.

1. Begin each question on a new sheet of paper
2. Write your name at the top of every page

3. Write the names of collaborating students at the top of the first page for each problem. Collaboration and group work is encouraged to enhance learning.

4. Show all work/calculations (i.e. numerical answers that do not show which formulas and/or calculations were used will not receive full credit, even if the answer is correct)

5. If you use Excel, MATLAB, etc. to answer a question print out your excel sheet/MATLAB code/etc.

Homework Collaboration Policy:

1. List all students that worked together at the top of each problem.
2. .
3. Each student must write up his or her own solutions.

4. Failure to do this may result in the assignment being discounted, and possibly more serious consequences.

Late Homework Policy:

Homework handed in after the end of class will be considered late.

Lateness	**Total taken off HW score**
Same day (After HW is collected in class	20 %
2nd Day	40 %
3rd Day (Last day to hand in HW)	60 %

Grading Scheme

A+	95-100
A	90-94
A-	87-89
B+	84-86
B	79-83
B-	74-78
C+	70-74
C	65-70
C-	60-65
D	57-60
F	<57

Teaching Fellow: Alexander Li

Contact Information:

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Office Hours:

By appointment