14.125:303 Biomedical Transport Phenomena

Lectures (Required): **Tuesdays and Thursdays, 1:40-3:00 PM**
Recitation (Optional): **Fridays, 1:30-230 PM**
Location (BME): **BME Room 116 (T, Th) / BME Room 126 (F)**
Credits (Total): **3 Credits**

Prerequisites (3): * Differential Equations (01:640:244) and
* Introduction to Biomedical Engineering (14:125:201) and
* Physiology for BME (14:125:255 or 14:125:355)

Faculty Instructor:
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Graduate Teaching Assistant:
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Wed 430-530PM (and appointment)

Course description: This course provides fundamentals on transport phenomena in biological systems, with an emphasis on physical and chemical mass transport processes that are related to artificial organs and tissue engineering applications. The course covers fundamental topics of thermodynamics, fluid mechanics and heat and mass transport in biomedical systems and technologies.

Objectives: To provide students with fundamental principles of physics and engineering related to the transport phenomena. Upon completion of this course, students will learn:

- To recognize diffusion-based problems and formulate appropriate mathematical constructs for the solution of mass transport problems.
- To comprehend the approach for quantitatively describing diffusion processes through homogeneous or heterogeneous media in physiological systems.
- To integrate the fundamentals of diffusive and membrane transport within technological problems applied to the fields of tissue engineering, bioartificial organs, drug delivery and biotechnology.

Textbook (Optional)**:** 'Welty JR, Wicks CE, Wilson RE, and Rorrer GL, 'Fundamentals of momentum, heat, and mass transfer,' John Wiley and Sons Inc., 5th Edition. Please see class website.

ABET Outcomes and Assessment: Three primary course outcomes will be achieved as per department metrics of accreditation, available at https://soe.rutgers.edu/abet-biomedical-engineering-bme

(a) an ability to apply knowledge of mathematics, science and engineering
(c) an ability to design a system, component or process to meet desired needs
(e) an ability to identify, formulate and solve engineering problems

Academic Integrity: Cheating of any kind will result in course de-registration and/or disciplinary action within the School of Engineering. Students are expected to adhere to university policy on academic integrity, available at http://cat.rutgers.edu/integrity/policy.html#Integrity.

Course Website: https://canvas.rutgers.edu/

Support Services: Students of all abilities are welcome in the BME educational program. https://ods.rutgers.edu/faculty/syllabus-statement

CAPS (Counseling, Alcohol and Other Drug Assistance Program & Psychiatric Services):
Open Walk in Hours on Thursdays 10-11AM in BME 130A (Ms. Fanteema Barnes-Watson, LCSW)

Grading Policy: The overall course grade will be determined using multiple types of assessment throughout the semester, as described below.

Examinations	(3, Closed Book)	60%
Homework	(12, iClicker-based)	10%
Quizzes	(9, In-Class Handout)	20%
Lecture Participation & Attendance (28 Lectures)		10%

Homework Assessments: The intent of HW is to help students develop technical skills outside of lecture and recitation. This course will assess skills development via in class HW rather than by traditional take home problems. A 5-min, multiple choice HW problem will be administered at the beginning of selected classes. HW will be submitted electronically using the iClicker system on the dates marked on the syllabus. Each HW assessment will review the concepts discussed in the 1-2 lectures prior and requires that students read carefully over their class notes and assigned readings. Each HW is an individual assignment, closed book, with no partial credit. No makeup HW will be given.

Quiz Assessments: Quizzes will be used to provide feedback on technical performance periodically throughout the course. Each quiz is comprised of one comprehensive, technical problem that is handed in within the first 20-min of class. Quiz problems are submitted individually and require handwritten solutions that will be graded using partial credit as appropriate. Each quiz is closed book and closed notes. No makeup quizzes will be administered.

Examinations: Examinations will assess individual student performance using 1-2 comprehensive, technical problems. The exams are more rigorous than course HW or quizzes, but cover the same material. Each exam is closed book. NO makeup exams will be administered without documentation of conflict(s) in advance. Please see the instructor immediately if applicable.

Participation: Students are expected to attend every lecture on time and to participate in classroom dialog. Please ask questions and be ready to discuss questions and problems posed in class. Students don't always have to know the correct answer, but should be prepared to guess intelligently. *Please be courteous and silence electronic devices during each lecture period.*

Lecture Format: Each lecture will follow the general format shown below. Students will work with 2-3 neighboring classmates to formulate solutions to transport problems posed during each class. Optional recitation sections will supplement problem solving by deriving detailed solutions to a technical problem not previously discussed in lecture.

Administrative Items and Review/Assessment	10-20 min
Technical Lecture (PPTs with Whiteboard)	30-40 min
In Class Technical Problem (Student Workgroups)	10-15 min
Discussion and Recap of Lecture Concepts	15-20 min

Course Policy: The following is an anticipated course syllabus. The instructor reserves the right to modify course material as needed to aid student preparation and retention of technical concepts.

LEC	DATE	GENERAL TOPICS PER LECTURE	ASSESSMENT	READING
1	01-21	Introduction & Overview		
2	01-23	Review of Physical Properties; Phases of Matter	HW1	Ch1
3	01-28	Review of Mathematics and Dimensions (SI)	HW2	Ch1
4	01-30	Forces, Energy Work; Ideal vs Real Models	HW3	Ch2
5	02-04	Fluid Static Forces, Properties, and Applications	Q1	Ch2,Ch3
6	02-06	Control Mass & Volume- Conservation Equations	HW4	Ch3,Ch4
7	02-11	Conservation of Mass	Q2	Ch4
8	02-13	Inviscid Flows	HW5	Ch4
9	02-18	Recitation-In-Class Review	Q3	
10	**02-20**	**EXAM I (States and Equilibrium)**		
11	02-25	Fundamentals of Fluid Flow (Navier-Stokes)	-----	Ch4, Ch7
12	02-27	Viscous Flow I: Couette Flow	HW6	Ch7, Ch8
13	03-03	Couette Flow; Poiseuille Flow	HW7	Ch12, Ch13
14	03-05	Poiseuille Flow; Internal Flows	Q4	Ch7, Ch8
15	03-10	Viscous Flow II: Complex Problems	HW8	Ch12, Ch13
16	03-12	Models of BME Tissues & Systems	Q5 Sample	
	03-17	------- ***Spring Break*** ------		
	03-19	------ ***Spring Break*** -------		
17	03-24	Fluid Flow Applications in BME	Q5 (Actual)	
18	03-26	Problem Review II (Lectures 1 – 17)	Q6 (Sample)	
19	03-31	Quiz 6 + Review	Q6 (Actual)	
20	**04-02**	**EXAM II (Fluid Flow)**		
21	04-07	Modes of Heat Transfer in BME Applications (Podcast)	-----	Ch15
22	04-09	Heat Exchange in Fluid Flows (Podcast)	HW9	Ch15, Ch16
23	04-14	Conduction and Biomaterials (Podcast)	HW10	Ch16
24	04-16	Convective Flows (Live Lecture)	Q7	Ch19, Ch20
25	04-21	Modes of Mass Transfer (Podcast)	HW11	Ch24
26	04-23	BME Mass Transfer Applications (Podcast)	HW12	Ch24, Ch25
27	04-28	Transport Models in BME (Live Lecture)	Q8	
28	04-30	Problem Review III (Live Lecture)	---	
		EXAM III (Heat and Mass Transfer)	Finals Week	