Fall 2015

BE4337, 5337 Transport Phenomena In Biomedical Engineering

Instructor: Chuong (chuong@uta.edu)
Time: 5:30-6:50pm, Tuesday and Thursday
Classroom: ERB-130, ERB-280 (Computational Lab)
Textbook: Transport Phenomena in Biological Systems; Truskey, Yuan, Katz, 2nd ed.
TA: Ishan Khan (ishan.khan@mavs.uta.edu)
TA hours 10:00 am -12:00 pm, Tuesday and Thursday at lunch area (in front of ERB231)

Description:

A review of fundamental principles in momentum transfer, mass transfer, and heat transfer with their applications in the description of blood flow, capillary transport, interstitial fluid transport, lymphatic transport at normal and disease states, as well as the application in drug delivery. We then examine the applications in the design of artificial organs, including membrane blood oxygenator, kidney dialysis devices, and therapeutic applications including hyperthermia, hypothermia, transport of drug molecules in solid tumors, etc.

Objectives:

- To learn basic engineering principles of momentum, mass, and heat transfer in integrated form through an array of examples and analysis from biological systems (cellular, tissue, organ levels) and from the design of medical devices

- To be able to apply these principles, using quantitative methods based on fundamental physical laws, to solve problems in biology, of clinical significance, and problems in the design and development of medical devices, implants, including tissue-engineered constructs.

Learning Outcomes

1. The capability to apply mathematics (PDEs), science, and engineering principles, methodologies to formulate and to solve problems at the interface of engineering and biology, physiology, including processes leading to disease states.
2. The ability to interpret results from formulated engineering problems derived for living systems as well as the ability to infer and to make refinement for further insights at the interaction between living and non-living materials and systems.
3. Appreciation for the breadth and depth across the range of engineering topics and their applications in biological, physiological problems including medical devices that enhance the quality of health care delivery.

Prerequisites

Gen Tech Physics PHYS 1443, 1444, and undergraduate fluid mechanics

Course outlines:

1. Introduction of the course

A. Introduction To Physiological Fluid Mechanics.

2. Conservation and Momentum Balances.
3. Conservation Relations for Fluid Transport, Dimensional Analysis and Scaling.
4. Macroscopic Form of Conservation Relations and Applications of Momentum Transport.

5. Fluid Flow in the Circulation and Tissues.

B. Fundamentals And Applications Of Mass Transport.

6. Introduction to Mass Transport.
7. Combined Diffusion with Convection.
8. Transport in Porous Media
9. Trans-vascular Transport.

C. The Effect Of Mass Transport Upon Biochemical Interactions.

12. Cell Adhesion and Cell Signaling.
13. Oxygen Transport from the Lungs to the Tissues.
15. *Transport of Drugs and Macromolecules in Tumors.*
16. Transport in Organs and Organisms.
17. Heat Transfer in Biological Systems.

Project presentation:

Exams:

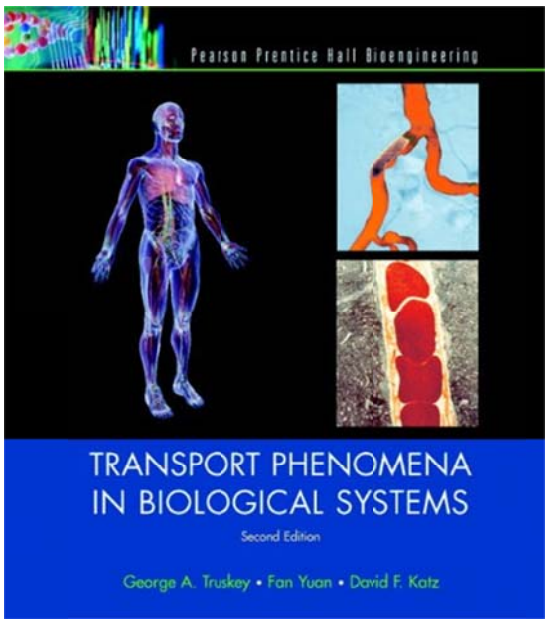
Two midterms and one final

Grading:

Homework	17.5%
Midterm 1	21.0%
Midterm 2	21.0%
Final	21.0%
Project with presentation	15.0%
Attendance and participation	4.5%

Late Homework

Homework set is due at 5:30 pm of the announced due date at the classroom (or otherwise specified). There will be penalty for late submission calculated as 10% for every one hour.



Specific outcomes from the class

Students should be able

- To describe the gas exchange at pulmonary capillaries and the concept of ventilation-perfusion matching
- To describe rheological properties and blood flow in systematic, pulmonary circuits.
- To describe fluid transport across capillary endothelia, interstitium, and the collection by lymphatic drainage and their regulation
- To design test chamber system that apply prescribed fluid shear on cultured cells
- To model mass transfer across membranes - applications to dialyzer and oxygenator
- To design scaled models and experiments based on dimension analysis and dynamic similarity - Reynolds, Womersley, Peclet, Sherwood #, etc
- To estimate to degree of heart valve stenosis using Bernoulli equation
- To describe peristaltic pumping and the use of lubrication theory in synovial fluid
- To describe fluid and solute transport in porous media with Darcy's law, Brinkman equation and the use of poro-elastic material description. Their applications in fluid and solute transport in interstitium and ECM.
- To describe drug transport in solid tumor

- To build CFD models to simulate blood/gas flow and exchange and drug delivery problems. From conservation of mass, momentum (NS eq), Fick's 2nd law to the problem formulation, numerical implementation and the finding, interpretation of numerical solution for different types of BME problems. (SolidWorks and COMSOL Computer Lab sessions)

Americans with Disabilities Act:
The University of Texas at Arlington is on record as being committed to both the spirit and letter of all federal equal opportunity legislation, including the Americans with Disabilities Act (ADA). All instructors at UT Arlington are required by law to provide "reasonable accommodations" to students with disabilities, so as not to discriminate on the basis of that disability. Any student requiring an accommodation for this course must provide the instructor with official documentation in the form of a letter certified by the staff in the Office for Students with Disabilities, University Hall 102. Only those students who have officially documented a need for an accommodation will have their request honored. Information regarding diagnostic criteria and policies for obtaining disability-based academic accommodations can be found at www.uta.edu/disability or by calling the Office for Students with Disabilities at (817) 272-3364.

If you require an accommodation based on disability, I would like to meet with you in the privacy of my office, during the first week of the semester, to make sure you are appropriately accommodated.

Academic Integrity and Academic Dishonesty:
It is the philosophy of The University of Texas at Arlington that academic dishonesty is a completely unacceptable mode of conduct and will not be tolerated in any form. All persons involved in academic dishonesty will be disciplined in accordance with University regulations and procedures. Discipline may include suspension or expulsion from the University. According to the UT System Regents' Rule 50101, §2.2, "Scholastic dishonesty includes but is not limited to cheating, plagiarism, collusion, the submission for credit of any work or materials that are attributable in whole or in part to another person, taking an examination for another person, any act designed to give unfair advantage to a student or the attempt to commit such acts."

Classroom and Office Emergency Actions for Faculty

Provided by Office of Emergency Management-817-272-0117

Siren-(Sounds like an air-raid siren)

If you are outside and hear a warning siren, go inside and turn on a weather alert radio, radio or a T.V. for information on actions to take. Sirens can be activated for 5 reasons:

1.) Tornado in the immediate area,
2.) Severe weather with winds over 70 mph,
3.) Large damaging hail,
4.) Elected official or President of the University designates siren activation for other emergencies and,
5.) Testing on the 1st Wednesday of each month at 12:30, if the weather is clear.

Lightning Siren-(Sounds like a train horn)

Siren identifies that there is a potential for lightning to strike in the area. Go inside as quickly as possible.

Utility Failure

If the lights go out, then call the Service Call Center-817-272-2000.
Give your name, phone #, building name, floor or area affected, and room #. Remain in your location. Fire panels, responders, or MavAlert will provide further instructions.

Evacuation

Leave the building by the nearest exit and go to an area that will not impede responder actions. Stand in an area far enough away that you are not affected by the event.

Fire Evacuation

As you leave the building, activate the building fire alarm, if it is not already sounding. Leave the building by the nearest exit and go to an area that will not impede responder actions. Call 9-1-1 **OR** if on campus Call 817-272-3003 from a campus phone or cell phone **OR** use the code blue emergency phones.

Active Shooter

If an active shooter is outside your building:

- Go to a room that locks, turn off lights, lock all windows, and stay out of sight. Silence your phone.
- Call 9-1-1 or UTA Police at 817-272-3003. If it is safe, stay on the line to provide information.
- Do not leave until given instructions to do so by Police or MavAlert.

If an active shooter is in the same building as you:

- If the room locks, follow the procedures above.
- If the room cannot be locked, then determine if there is a room is nearby that does lock and can safely be reached, or if you can safely exit the building.

If an active shooter enters your office or class room:

- Dial 9-1-1 and give your location. If you cannot speak, leave the line open.
- If you cannot escape, attempt to negotiate. Only as a last resort should you attempt to overpower the shooter.
- If the shooter leaves the area, immediately go to a safer place. Call 9-1-1 or UTA Police at 817-272-3003.

Shelter in Place

Shelter-in-place means to take refuge inside a building. If time permits, select interior room(s) below ground floor, with the fewest windows or vents. If there is no time or space available, then follow instructions below.

- Stop work or class.
- Do not go outside.
- Close and lock all windows, exterior doors, and any openings to the outside.
- Listen to fire panel, radio, television, or MavAlert for further instructions.