BIEN 105: Circulation Physiology
Winter 2017

COURSE OUTLINE

Course Time: LEC: (MWF) 02:10 P.M. - 03:00 P.M., WCH 138
DIS: (M) 11:10 A.M. - 12:00 P.M., WCH 142
DIS: (F) 10:10 A.M. -11:00 A.M., WCH 142

Instructor: V. G. J. Rodgers (215 MS&E) victor.rodgers@ucr.edu
W 3:10 -5:00 PM and by appointment (please email)

T.A.: Dieanira Erudaitius (A133 Bourns Hall) derudait@gmail.com
Office Hours W 1:00 PM – 2 PM
F 9:00 AM – 10 AM

Textbooks: *Transport Phenomena in Biological Systems*, George A. Truskey, Fan Yuan, David F. Katz, Prentice Hall (January 2, 2009), 2nd Edition, ISBN-10: 0131569880, ISBN-13: 978-0131569881

Other References: *Biofluid Mechanics: The Human Circulation*, K. B. Chandran, A. P. Yoganathan, and S. E. Rittgers, CRC Taylor & Francis, Boca Raton, FL (2007) ISBN-10: 084937328X

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

Topic Description:

Like all things in nature, biological processes also follow the conservation laws governing momentum, energy and mass. This is broadly classified as transport phenomena. Circulation physiology specifically addresses processes associated with the conservation of momentum pertaining to fluids of the body. In biomedical and biological systems this is arguably one of the most important fields to large-scale biological structures such flow of blood through the arteries and other blood cells, and even how molecules of cells interact with each other. As bioengineers, fundamental grounding in biomechanics is essential. This course will provide the introduction to such a foundation.

Course Summary (from Course Catalog)

Introduces tensor and vector mathematics that describes the conservation of momentum and mass transport in biological systems; the cardiovascular system, and the pulmonary system. Topics include applied tensor and vector mathematics, constitutive equations such as Navier-Stokes, power-law and Casson models; significance of fluid stress in biological vessels, and the physiological relevance of fundamental parameters such as shear stress and vorticity. Emphasis is on the relation between function and system behavior.

Course Goals

So, by the end of this course, you will strengthen your skill level so that:

i. You will be able to understand the basic governing momentum conservation equations and associated basic constitutive equations for describing biofluid processes.

ii. You will be able to apply these governing equations to real biological systems and describe these systems mathematically, develop strategies to analyze the biofluid problem, recognize particular behavior of real processes, and recognize limitations in approximating the process.

iii. You will have developed an ability to utilize practical and mathematical tools, an ability to logically think through biomechanical problems from conception to design, and be familiar with the relative significance of your results.

iv. You will have had opportunities to further your professional development through practicing written and oral communication skills, working on group assignments, and using modern computer tools.

v. You will demonstrate confidence in assessing and developing basic mathematical/computational models of biomechanical problems.

vi. AND, you will demonstrate professional accountability for your engineering design analysis.

Prerequisites

A background in engineering mathematics including vector calculus and statics is necessary. Since solutions will be obtained using numerical methods, working knowledge of computer manipulation and programming is helpful. Commercial computing tools such as COMSOL will be used extensively in the homework and projects. Therefore, students must obtain an engineering computer account.

Grading:

The grading will consist primarily of two closed-book exams (Confidence Builders), two reports of the one quarter-long continuous group project, final project presentation and homework. The homework will be reviewed with the primary concern being effort and professionalism. Therefore it is essential to the student that they are responsible for their individual understanding of the problems and their assigned purpose. To this end, I will have an open-door policy for help and support with any aspect of this course. Answers to the homework will be made available during discussion sessions. No homework will be accepted late. The closed-book exams will be on the fundamentals of vector field theory and momentum transport as applied to biological systems. The remaining project will be based on a biomechanics topic where the students (with approval) choose independent topics. It is expected that the students will be resourceful with projects using tools outside of those presented in this class if necessary. Presentations of the results, both written and oral, will be essential parts of the grade.

Schedule

Week 1:	Applications of Fluid Mechanics and Mass Conservation (Chapter 1 and Notes)
Weeks 1 -2:	Introduction to COMSOL (During Discussion)
Week 2:	Introduction to Vector and Tensor Mathematics (Notes)
Week 3:	Introduction to the Conservation of Momentum (Chapter 2)
Week 4-5:	Tensor Representation of Momentum Conservation (Chapter 3)
Week 5-6:	Analytical and Approximate Solutions to Complex Problems (Chapters 3 and 4)
Week 7:	Conservation of Mass (Notes and Chapter 7)
Week 8:	Applications of Mass Conservation to Biological Systems (Chapter 6 and 7)
Week 9-10:	Transport with Reactions in Biological Systems (Chapter 10)

Exam Schedule and Grading:

EXAM	POINT	DATE and DATE
Assign Groups		January 16, 2017
Project Assigned		January 18, 2017
Homework	100	Weekly
1st Confidence Builder	200	February 15, 2017
1st Project Report	100	February 17, 2017
2nd Confidence Builder	200	March 17, 2017
Project Presentation	100	March 24, 2017 (7:00 P.M. - 10:00 P.M.)
Final Project Report	300	March 24, 2017(6:00 P.M.)
TOTAL	**1000**	

Basic Format for Project Reports

The reports should be typed and typically include:

1. Introduction
2. Theory
3. Experiments
   - Apparatus
   - Procedure
4. Results and Discussion
5. Conclusions and Recommendations
6. Bibliography
7. Appendices
   - Raw Data
   - Sample Calculations

Final Thoughts

Keep in mind that this course is part of your final leg in this long journey to become bioengineers. It is comprehensive in that you will have the opportunity to utilize techniques in mathematical modeling to simulate processes (design) and then compare their results to actual dynamic process performance. Even though the course will be rigorous at times, keep in mind that this course can be a lot of fun.

Collaboration Policy

Any questions about homework problems or laboratories should be addressed to Professor Rodgers. Discussion of homework problems and laboratories with other students in the class is acceptable but direct copying of complete or part of an assignment is not allowed. Violation of this policy will result in a zero given for the homework set. Cheating on exams may result in an F grade given for the course.