Jordan University of Science and Technology

Faculty of Engineering

Biomedical Engineering Department

BME 531A: Physiological Modeling

Course Catalog

Design of system elements, case studies of medical system examples, computer-aided design methods, design of subsystems, product reliability. Dynamic modeling and control of selected biological and physiological processes.

Text Book(s)

Title	Mathematical and Computer Modeling of physiological systems.
Author(s)	Vincent C.Rideout
Publisher	Prentice Hall
Year	1996
Title	Physiological Control Systems - Analysis, Simulation, and Estimation
Author(s)	Michael C.K Khoo
Publisher	IEEE Press/John Wiley
Year	2000

References

Books

- **Mathematical Modelling of Dynamic Biological Systems**
  Ludwik Finkelstein & Ewart R. Carson (1986)
- **Modelling Dynamic Biological Systems**
  Bruce Hannon & Matthias Ruth (1997)
- **Introduction To Matlab For Engineers**
  William J. Palm III (2005)
- **Mathematical Models in Biology**
  Leah Edelstein-Keshet (1988)
- **A First Course in Mathematical Modeling**
  Franck R. Giordano, William P. Fox, Steven B. Horton & Maurice D. Weir(2009)
- **Mathematical Modeling in The Life Sciences**
  Paul Doucet & Peter B. Sloep (1992)
- **Modeling Differential Equation in Biology**
  Clifford Henry Taubes (2008)
- **Modeling and Simulating in Medicine and the life sciences** (2nd edition)
  Franck C.Hoppensteadt and charles S.Peskin Springer,New York,2002
- **Introduction to Biomedical Engineering**
  John ENderle, Elsevier, 1999, Second

Journals	• Annals of Biomedical Engineering • Journal of Medical Engineering and Technology • Computer Programs and Methods in Medicine • Medical Engineering and Physics • IEEE EMBS Book Series • IEEE Transactions on Biomedical Engineering • IEEE Transactions on Information Technology in Biomedicine • Physiological Measurement
Internet links	• http://www.bmes.org/ • http://arjournals.annualreviews.org/loi/bioeng?cookieSet=1 • http://www.aami.org/publications/BIT/index.html • http://www.biophysj.org/ • http://emb-magazine.bme.uconn.edu/ • http://emb-magazine.bme.uconn.edu/ • http://www.iee.org/Publish/Journals/ProfJourn/MBEC/ • http://spie.org/app/Publications/index.cfm?fuseaction=journals&type=jbo • http://www.biomedical-engineering-online.com/start.asp

Prerequisites	
Prerequisites by topic	Biomedical Transport Phenomena
Prerequisites by course	BME 452
Co-requisites by course	NA
Prerequisite for	Artificial Organs, Bioinformatics

Objectives and Outcomes

Objectives	Outcomes
To provide the students with a guide to mathematical modeling techniques (a,b,c,d,e,g,k)	• Learn how to describe systems using Laplace transform and differential equations • Solving the mathematical models using different numerical and analytical method.
To provide the students with a tool for simulation physiological systems (a,b,c,d,e,g,k,l)	• Learn how to use Matlab/Simulink as simulation software. • Use Simulink to simulate physiological systems
Understand how to build, analyze and develop models for physiological systems(a,b,c,d,e,g,k,l)	• Develop and build engineering models that describe pressure flow systems such as cardiovascular and respiratory function
Understand the simulation and control of selected physiological processes and biological systems (a,b,c,d,e,g,k,l)	• Simulate cardiovascular systems and Mass-Transport compartment modeling • Analyze Pharmacokinetic System

Topics Covered

Week	Topics	Chapters in Text
1	**Introduction to mathematical modeling**	**Chapter 1 (Text 2) and notes**

	using Matlab/Simulink/Berkeley	
2-3	**Mathematical Modeling**	**Chapter 2 (Text 2) and notes**
4	**Static analysis of physiological systems**	**Chapter 3 (Text 2) and notes**
5-6	**Analysis of linear systems**	**Chapter 4 (Text 2) and notes**
7-8	**Pressure flow modeling. Cardiovascular modeling.**	**Chapter 4 (Text 1) and notes**
9-10	**Respiratory system modeling**	**Chapter 5 (Text 1) and notes**
11-12	**Mass Transport :Compartment Modeling**	**Chapter 2-3 (Text 1) and notes**
13-14	**Multiple Modeling**	**Chapter 6 (Text 1) and notes**
15-16	**Heart flow and Thermoregulation Modeling**	**Chapter 7 (Text 2) and notes**

Policy	
Attendance	Class attendance is required and applied according to the university regulations (**student's guide page 43**). Data support the idea that class attendance improves learning. It is very difficult as well as uninspiring for me to help a student who does not attend lectures. What is created in the classroom cannot be reenacted. Make-up tests will be done according to the university regulations. Please see student's guide pages 44-45.
Homework	Working homework problems is an essential part of this course and they represent a key opportunity to learn the subjects discussed. All homework problems assigned during a given week are due at the beginning of class on the second meeting of the following week unless otherwise stated. Late homework will not be accepted. Failure to turn in this particular homework **on time** will result in a grade of 0 (zero) for the homework contribution to your final grade. Team work is encouraged; however, the work one hands in must represent his/her own effort. Homework solutions will be discussed in class. There will be no handouts of homework solutions.
Student Conduct	All University regulations apply to this course. In particular, the policies concerning academic dishonesty and withdrawal from a course apply.

Teaching & Learning Methods
- Active learning, where students should be active and involved in the learning process inside the classroom, will be emphasized in the delivery of this course. - Different active learning methods/approaches such as: Engaged Learning, Project-Based Learning, Cooperative Learning, Problem-based Learning, Structured Problem-solving, will be used. - The teaching method that will be used in this course will be composed of a series of mini lectures interrupted with frequent discussions and brainstorming exercises. PowerPoint presentations will be prepared for the course materials. - A typical lecture would start with a short review (~ 5 minutes) using both PowerPoint presentations and the blackboard. This review will also depend on discussions which will gauge the students' digestion of the previous material. Then, the students would have a lecture on new materials using PowerPoint presentations and blackboard. The lecture presentation will be paused every 15 – 20 minutes with brainstorming questions and discussions that will allow the students to reflect and think in more depth about what they learned in that presentation. Then, some example problems will be presented and discussed with the students to illustrate the appropriate problem solving skills that the students should learn. The lecture will be continued for another 15 – 20 minutes, followed by examples and/or a quiz covering the materials taught in the previous two weeks.

Evaluation		
Assessment Tool	**Expected Due Date**	**Weight**
Homework, Project and quizzes	One week after homework problems are assigned	10%
First Exam	According to the University examination schedule	25 %
Second Exam	According to the University examination schedule	25 %
Final Exam	According to the University final examination schedule	40 %

Contribution of Course to Meeting the Professional Component
The course contributes to building the fundamental basic concepts in Biomedical Engineering and Modeling.

ABET Category Content	
Engineering Science	3.0 Credit
Engineering Design	

Modelling and simulation of physiological systems. Outline. Chapter 1: HOMEOSTASIS OF THE BODY: CONTROL ASPECTS.Â Chapter 7: MATHEMATICAL MODELS OF THE BIOLOGICAL AGE OF THE RAT. Chapter 8: NUMERICAL SIMULATION OF WATER TRANSPORT IN EPITHELIAL JUNCTIONS. Chapter 9: ANALYTIC PROPERTIES AND IDENTIFIABILITY PROBLEMS OF COMPARTMENTAL MODELS WITH TIME-LAGS. Chapter 10: THE MODELLING OF TAGGED PARTICLES MIGRATION IN PHYSIOLOGICAL SYSTEMS. Chapter 11: CRITERIA FOR COMPUTER SIMULATION OF DRUGâ€"RECEPTOR INTERACTION. Chapter 12: A NEW STOCHASTIC APPROACH TO COMPARTMENTS WITH COMBINED CROSS-SECTION AND TIME-SERIES DATA. Mathematical and theoretical biology is a branch of biology which employs theoretical analysis, mathematical models and abstractions of the living organisms to investigate the principles that govern the structure, development and behavior of the systems, as opposed to experimental biology which deals with the conduction of experiments to prove and validate the scientific theories. The field is sometimes called mathematical biology or biomathematics to stress the mathematical side, or theoretical Books. Text Book(s). Mathematical and Computer Modeling of physiological systems. Vincent C.Rideout Prentice Hall 1996 Physiological Control Systems - Analysis, Simulation, and Estimation Michael C.K Khoo IEEE Press/John Wiley 2000. References. â€¢ Mathematical Modelling of Dynamic Biological Systems.Â To provide the students with a tool for simulation physiological systems (a,b,c,d,e,g,k,l) Understand how to build, analyze and develop models for physiological systems(a,b,c,d,e,g,k,l) Understand the simulation and control of selected physiological processes and biological systems (a,b,c,d,e,g,k,l). Objectives and Outcomes. Outcomes. â€¢ Learn how to describe systems using Laplace transform and differential equations.