Syllabus, Biological Physics

Fall 2018

Class: Physics 3250, MWF, 8:00-9:07, 225 HH

Instructor: Brad Roth, Dept. Physics, 166 Hannah Hall, 370-4871, roth@oakland.edu, fax: 370-3408, office hours MWF, 9:15-10:00, https://files.oakland.edu/users/roth/web

Text: Intermediate Physics for Medicine and Biology, 5th Edition, by Hobbie and Roth
(An electronic version of this book is available for free through the OU library)

Goal: To understand how physics influences and constrains biology

Grades:

Exam 1	Oct 1	25 %	Chapters 1-3
Exam 2	Oct 31	25 %	Chapters 4-6
Final Exam	Dec 10	35 %	Chapters 7-8, 10 & Comprehensive
Homework		15 %	

Final Exam Monday, December 10, 8-11 AM

Schedule:

Sept 5, 7	Chapter 1	Mechanics
Sept 10-14	Chapter 1	Fluid Dynamics
Sept 17-21	Chapter 2	Exponential, Scaling
Sept 24-28	Chapter 3	Thermodynamics
Oct 1-5	Chapter 4	Diffusion
Oct 8-12	Chapter 5	Osmotic Pressure
Oct 15-19	Chapter 6	Electricity and Nerves
Oct 22-26	Chapter 6	Action Potential Propagation
Oct 29-Nov 2	Chapter 7	Extracellular Stimulation
Nov 5-9	Chapter 7	Electrocardiogram
Nov 12-16	Chapter 8	Biomagnetism
Nov 19, 21	Chapter 8	Magnetic Stimulation
Nov 26-30	Chapter 10	Heart Arrhythmias
Dec 3-7	Chapter 10	Feedback
Dec 10	Final Exam	

Homework

Chapter 1: 2, 6, 7, 16, 17, 33, 40, 42	due Fri, Sept 14
Chapter 2: 3, 5, 10, 29, 42, 46, 47, 48	due Fri, Sept 21
Chapter 3: 29, 30, 33, 34, 40, 41, 47, 48	due Fri, Sept 28
Chapter 4: 8, 12, 20, 22, 23, 24, 41, 42	due Fri, Oct 12
Chapter 5: 1, 3, 5, 6, 7, 8, 15, 16	due Fri, Oct 19
Chapter 6: 1, 2, 22, 25, 28, 35, 41, 43	due Fri, Oct 26
Chapter 7: 1, 10, 24, 25, 26, 42, 47, 51	due Fri, Nov 16
Chapter 8: 10, 13, 24, 25, 27, 28, 29, 32	due Fri, Nov 30
Chapter 10: 12, 16, 17, 18, 40, 41, 42, 43	due Fri, Dec 7

Reading

Chapter 1: Sections 1-8, 12-13, 15-17, 19-20

Chapter 2: Sections 1-3, 8, 11

Chapter 3: Sections 7-11

Chapter 4: Sections 1-2, 6, 8-9, 11-13

Chapter 5: Sections 1-4, 7-8

Chapter 6: Sections 1, 6, 10-16

Chapter 7: Sections 1-8, 10-11

Chapter 8: Sections 1-7

Chapter 10: Sections 1-6, 9, 12

Goals

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

This class can be thought of as a workshop in applying mathematical modeling to problems in medicine and biology. We will apply the ideas of electricity to understand nerve conduction, and use the concepts of nonlinear dynamics to describe fibrillation of the heart.

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

We discuss many examples of solving engineering problems, including how to design an artificial kidney, diagnose arrhythmias using the electrocardiogram, and restore function to a limb using electrical stimulation.

A recognition of the need for, and an ability to engage in, life-long learning.

We will repeatedly identify books and other sources that allow students to learn on their own. When analyzing fluid dynamics we will discuss *Life in Moving Fluids* by Steven Vogel, and when studying diffusion we will consider *Random Walks in Biology* by Howard Berg.

A knowledge of contemporary issues

We examine many contemporary issues in biology and medicine, such as how to monitor brain function using magnetoencephalography and restore hearing using a cochlear implant.

An ability to use engineering tools necessary for engineering practice

We will apply the tools of mathematical modeling to study engineering problems, such as using the ideas of heat transfer to show how an animal uses fur to maintain its body temperature, and how feedback can control blood glucose via insulin production.

Apply the principles of physics to physiology, and mathematics to medicine.

We will apply physics and mathematics to problems in biology and medicine. For example, we will use the physics of diffusion to determine the largest size of a cell, and the mathematics of fluid dynamics to understand blood flow.

Solving biomedical engineering problems

We will examine several case studies about how to solve biomedical engineering problems, such as how to stimulate neurons in the brain using transcranial magnetic stimulation, and improve transport using a countercurrent heat exchanger.

Analyzing, modeling, designing engineering devices

We will analyze several engineering devices, from simple tools such as a cane to reduce forces on an injured hip, to complex machines such as a heart defibrillator.