Florida Atlantic University
Department of Computer and Electrical Engineering and Computer Science
Engineering Scholars Program

Introduction to Bioengineering

(3 credits)

Summer 2017

1. Course Description and prerequisites:

This course is a partly demonstrative and partly hands-on Bioengineering based course designed for students interested in advances in Biomedical engineering in both: Wet Lab and Computerized aspects (model simulation) of biological/medical phenomena. No prior background in Lab or Computer methods are assumed. The Bioengineering portion is covered through particular lectures from established Intro to Bioengineering and Tissue Engineering courses at FAU. The Computer based material and the design methods are covered through MATLAB and Simulink software simulation sessions and lectures. Computer modeling and simulation techniques are playing an increasingly central role in changing both the way medicine is taught and the way it is practiced. Fundamental to the art and science of modeling and simulation is an underlying assumption that insight into system behavior can be developed or enhanced from a model that adequately represents a selected subset of the system's attributes. The course lectures and labs experiences culminate in a design project competition of topics/models chosen and applied for presented simulation either theoretical topic presentation.
Prerequisites are not required for this course.

2. Course Objectives:

The course covers the fundamentals of Bioengineering potentials through lectures, calculative approaches, and practical 3-D printing of the prosthesis known as the Bionic glove, as well as MATLAB and Simulation lectures dedicated to specific models: classical (Malthusian, Verhulst, Predator-Prey), and modernized, (Excel spreadsheet data presentation). By combining lectures and practical computer lab activities and animations, students will get the insight into the integration of simulation techniques with other types of applications.

Students will learn about stem cells, scaffolds and molecules of intracellular interaction in Tissue Engineering, basic calculations necessary for engineering different cell-culture media, determining optimal cell patterns for defected tissues, and essential breakthroughs in significant avenues of this expanding area. They will also learn about graphical presentation of different models through MATLAB, based on differential equations. Students will explore the latest features and a customizable sets of block libraries that will

help them to establish/complete the models, through Simulink program (library of necessary components for given model). Students will spend half of their class time in the lab conducting either guided simulations, doing analytical calculative solutions, presenting data in Excel, or doing rapid prototyping on 3D printer. The other half of the class time will be divided between the lectures and animations necessary for correct visualization of certain procedures in Biomedical engineering. Due to the special time format constraints (9 full class days spread over three weeks) the course is fast paced and homework-intensive (team lab technical reports/presentations and individual computer and lab assignments).

3. Course outcomes:

a) Students will develop deep understanding of the most significant breakthroughs in Bioengineering especially in medical arena in scientific search for improvement of human health.
b) They will learn the basic calculative operation used in the Wet Bioengineering Lab.

d) Students will be exposed to experience of 3D printing and do the basic assembly and evaluation of products (prostheses, or bionic hands)

c) They will also develop basic understanding of the modeling processes through MATLAB and Simulink, e.g. how to integrate the programs and simulate the linear and non-linear changes within particular models, based on specific parameters

b) They will receive a good understanding of basic linear and nonlinear dynamic properties, normalization (scale changes), computer-aided analysis, simulation and control of selected physiological processes and medical/biological systems

c) Students will be able to not only graphically present manifestations of a specific facet of given medical/biological phenomena, but also to manipulate/tune changes in the graph (background, labeling, and colors).

d) Students will form the lab teams and learn how to research and present the topics, collect the experimental data and how to process it and present in their team reports and homework

4. Reference Books :

Introduction to Bioengineering
Conceptual Approach
Mirjana Pavlovic
Springer, New York, 2015

Mathematical Modeling in Systems Biology – An Introduction
Brian Ingalls
MIT Press, 2013

5. Reference(optional):

Modeling and Simulation in Medicine and the Life Sciences
(2nd Edition)
Frank C. Hoppensteadt and Charles S. Peskin
Springer, New York, 2002.

6. Required:

Visit Peskin's web page www.math.nyu.edu/faculty/peskin
Download the Matlab m. files for Chapters 1 and 3 of his book (tent)

7. Resources:

All notes (PowerPoint lectures, instructions and notifications) as well as class related announcements will be posted on the course's web-page (http://blackboard.fau.edu). Students should download and bring to class either the electronic or printed latest versions of the lab and computer lab manuals at the appropriate dates shown in this syllabus.

8. Grading scheme:

6 Homework Assignments (2 per week-individually)	36%
3 Computer Lab reports (2 from MATLAB+SIMULINK and 1 Excel)	28%
6 Equally weighted quizzes (2 per week)	21%
Instructor's Assessment of Lab Participation and Work Quality	7%
Instructor's Assessment of the Final Project (team)	8%
	100%

1. Six equally weighted quizzes (each counts for 3.5%) will be given on the dates shown. Each quiz will be 15 minutes long. Quizzes will be based on the lecture and understanding of the role of topic in biomedical science/bioengineering.
2. Every report will be letter graded (A, B, C, etc.)
3. Final Project grade will be based on demonstrated understanding of MATLAB – SIMULINK operation, or some chosen topic from Biomedical Lab Techniques. Grades are individual.
4. The numerical overall grade is translated to the alphabetical FAU grade system, using the following key:
   A 90-100%, A-85-89%,B 75-79%,B-70-74%,C+ 65-69%, C60-64%, etc.
5. There will be no grade curving of any sort. All final grades that will come within 1% of a grade threshold will be reviewed for possible special consideration based on the student's demonstrated consistent effort throughout the course.

9. Instructor and contact information:

Dr Mirjana Pavlovic 561-297-2348 mpavlovi@fau.edu

Teaching Assistant: TBA

10. Class dates, time and location :

Meeting places and times: see calendar (below)

Classroom locations:

Lab: TBD

Lecture: TBD

11. Course scheduled details:

Monday, June 12

9:30-9:45 Orientation
10:00-11:25 Lecture: (Introduction to Bioengineering: general remarks)
11:30-12:30 Computer Lab: (Access to MATLAB and Simulink)
12:30-1:30 Lunch
1:30-4:30 Lecture: (Differences between Wet and Computer Lab used in Bioengineering: Wet-Laboratory procedures in Bioengineering: Animations)

Wednesday, June 14

9:30-12:30 Lecture: (The use of stem cells in Medical arena: entities, patterns, optimization and transplantation. Concepts of Cell and regenerative therapy.)

12:30-1:30 Lunch

1:30- 4:30 Computer Lab: (Wet- Lab calculus: use of computer and BB).

Friday, June 16

9:30-12:30 Lecture: (Cancer Stem Cell Concept and targeted therapy; concepts of drug delivery)

12:30- 1:30 Lunch

1:30-4:30 Computer Lab: (Mechanisms of targeted drug delivery: animations. Remote control)

Monday, June 19

9:30 -12:30 Lecture: (Tissue engineering as essential topic in Biomedical engineering)

12:30-1:30 Lunch

1:30-4:30 Computer lab: (TE calculus: media, concentrations, cells, growth)

Wednesday, June 21

9:30-12:30 Lecture: (Artificial organs and transplantation without a donor)

12:30-1:30 Lunch

1:30-4:30 Computer Lab: (Animations: Different bioengineering Labs in the world and their topics)

Friday, June 23,

9:30-12:30 Lecture: (Mirjana Pavlovic and Chad Coarsey): 3D printing-Rapid prototyping and BIONIC GLOVES)

12:30-1:30 Lunch

1:30-4:30 3D printing Lab: (printing, assembling, etc.)

Monday, June 26

9:30 -12:30 Lecture: (Modeling and Simulation in Medicine: State of the Art)

12:30-1:30 Lunch

1:30-4:30 Computer Lab: (MATLAB+SIMULINK tutorials (via analysis of Population Growth Dynamics): Malthusian Growth, Verhulst Logistic curve, Predator-Prey models and their Applications in Biomedical Engineering: cell culture exponential growth, confluent and subconfluent cultures, cellular “cannibalism”).

Wednesday, June 28

9:30-12:30 Lecture: (Data normalization/linearization)

12:30-1: 30 Lunch

1:30-4:30 Computer Lab (Excel Spreadsheet: Data presentation)

Friday, June 30

9:30-12:30 Lecture: (Breakthroughs in Bioengineering with emphasis on Biomedical Topics nanotechnology, bio imaging, bioinstrumentation,).

12:30-1:30 Lunch

1:30-4:30 Computer Lab: (Student team presentations: chosen topics either from mathematical models or Bioengineering topics)

12. Submission of Homework, Computer Lab Reports and Presentations requirements:

1. Homework is due the morning of the next class day, individually. It should be brief and involve answers to questions and solutions to the problems.

2. The computer lab reports are due also the morning of the next class, by each team. Each team should submit one brief report per experiment. The report should include the relevant simulation results in two cases and one Excel result.

3. The final report should be submitted on the last day of course in written and Power Point format and presented orally by each team.

4. All students are expected to be active participants of the team. Students who consistently let their lab partners do most of the work may lose the entire percentage of the grade in corresponding category.