BIOM 315: Computational Biomedical Engineering
Tue & Thu, 11:00a-12:15p, MR-5 1041

Instructor
Jason Papin; email: papin@virginia.edu
Office Hours: Wed., 9am-10:30am in MR-5 room 2041-B

Teaching Assistant
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Course webpage
Collab page for BIOM 315 (http://collab.itc.virginia.edu/)
Lectures, homework, and announcements will be posted, so please check regularly.

Course objective
This class has the following major goals:

- To help you further develop your skills in developing mathematical and computational models for systems. Such models often provide new insights about biological or engineering systems. As such, models represent a pathway for exploration that is often complimentary to experiment. Furthermore, models are critical tools for predicting the behavior of engineered systems and therefore are an essential part of the design process.
- To introduce you to numerical methods, powerful techniques for solving complex, real-life problems.
- To integrate knowledge gained from other courses (e.g., transport, mechanics, cell & molecular biology) in a computational framework.
- To strengthen and expand your computer programming skills. We will not focus on the details of implementing detailed algorithms, but rather on developing the skills needed to apply existing routines as well as developing a sense of the limitations and dangers of numerical methods. We will use MATLAB extensively and draw upon existing functionality whenever it is available.

To achieve these goals we will use a combination of lectures, homework, exams, and a final project. Much of this work will allow and encourage team cooperation; however, you should recognize the need for you as an individual to be proficient in all aspects of the material.

Textbooks

Numerical Methods in Biomedical Engineering, 2006, by Dunn, Constantinides, Moghe (**Required**)

Engineering Computation with MATLAB, 2007, by Smith (**Recommended**)

Lecture, Homework, & Exam Schedule

1/17 – Introduction to computational biomedical engineering
1/22 - Linear algebra review
1/24 - Computers and Numbers; Introduction to Matlab
HW #1 assigned (introduction; linear algebra) - due 2/5
1/29 – WORKSHOP - Matlab introduction; please bring computers if available

Section I – <u>Model Creation</u>
1/31 - Model creation process & examples
2/5 - Data-based models – regression; ***HW #1 due***
2/7 - Data-based models – interpolation
HW #2 assigned (model-building, curve fitting) – due 2/14
2/12 – GUEST LECTURE – Dr. Ed Hall – Improving Matlab code performance

Section II – <u>Organ-Level Models</u>
2/14 - Numerical differentiation & integration; ***HW #2 due***
2/19 - Root finding
HW #3 assigned (differentiation, integration, root finding) – due 2/26
2/21 – GUEST LECTURE – Dr. Chris Estey – Nonlinear root finding
2/26 – **EXAM #1; *HW #3 due***
(introductory concepts, model-building, curve-fitting, numerical differentiation & integration, root finding)

Section III – <u>Cell-Scale Models</u>
2/28 - Systems of linear & nonlinear equations – Part I
HW #4 assigned (systems of equations) – due 3/13
3/1 – 3/9 – Spring Break
3/11 - Systems of linear & nonlinear equations – Part II
3/13 - Optimization – Part I; ***HW #4 due***
3/18 - Optimization – Part II
HW #5 assigned (optimization) – due 3/25
3/20 - Linear programming
3/25 - Monte Carlo sampling; ***HW #5 due***

Section IV – <u>Molecular-Scale Models</u>
3/27 - ODEs – Part I
HW #6 assigned (Monte Carlo sampling; ODEs) – due 4/3
4/1 - ODEs – Part II
4/3 - PDEs – Part I ; ***HW #6 due***
HW #7 assigned (ODEs, PDEs) – due 4/10
4/8 - PDEs – Part II
4/10 - **EXAM #2; HW #7 due**
(systems of equations, optimization, linear programming, sampling, ODEs, PDEs)

Section V – Advanced Examples
4/15 – GUEST LECTURE – Dr. Feilim MacGabhann - Tissue morphogenesis
4/17 – GUEST LECTURE – Dr. Craig Meyer - Image processing
4/22 - Project presentations I
4/24 - Project presentations II
4/29 – Project presentations III; GUEST LECTURE – Cellular networks; final comments

Final written projects due by Wed., 4/30, 4pm (although you can turn them in earlier)

Final Exam - (course material, advanced examples, class projects): Mon., May 5, 9-12

Grading
Late work will not be accepted for full credit unless there is prior written approval. Homework will be due at the very **beginning of the lecture** on the day it is due unless noted otherwise on the assignment. Some work will require electronic submission and will need to be submitted before the beginning of lecture on the day it is due. The procedure for turning in the homework will be indicated in class and noted on the class website. **You will lose 50% of the value of the homework on the homework for <u>each</u> day that it is late (in other words, it cannot be more than a day late or you will receive zero credit).**

You are encouraged to collaborate on homework, but **you will need to cite your collaborators and all submitted written work must be individual**. If there is any confusion about whether collaboration or drawing upon outside resources is allowed, please contact me.

Grades for the class will be determined using the following formula.

35%	Homework Assignments	(7 assignments – 5% each)
20%	Written Final Project	
5%	Final Project Presentation	
20%	Midterm Exams	(2 exams – 10% each)
20%	Final Exam	

Total: 100%

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