ILLINOIS

THE GRAINGER COLLEGE OF ENGINEERING
Department of Bioengineering
1102 Everitt Laboratory, MC-278
1406 W. Green St.
Urbana, IL 61801

BIOE 504: Analytical Methods for Bioengineering Fall 2023

Instructor: Michael Insana Offices: 2108 EL & 4247 BI, mfi@illinois.edu

Time and place: MW 9:00 am – 10:50 am, Room 3217 Everitt Lab.

Discussion and office hours are scheduled after class MW and by appointment most days.

Prerequisites: MATH 286, scientific programming, elementary statistics, or graduate standing

Required Books: "Biomedical Measurement Systems and Data Science," by MF Insana, Cambridge University Press, 2021 $120
www.cambridge.org/9781107179066

This core graduate bioengineering course is open to students from other engineering and science programs with graduate standing or undergraduates with permission from the instructor. The objective is to introduce and review a broad range of mathematical, statistical, and computational modeling methods related to data representation and measurement systems that are common to the design and evaluation of biomedical instruments and biological modeling. Assignments involve combinations of mathematical, statistical, and numerical modeling in Matlab.

Course grades are based on student performance on graded homework assignments (75%) and one take-home exam (25%).

Grades: A (85-100%), A- (80-84%), B+ (75-79%), B (70-74%), B- (65-69%), C (<65%)

Semester Schedule:

Classes begin	Monday August 21
Labor Day Holiday	Monday Sept. 4
Thanksgiving Holiday	Nov. 18 – Nov. 28
Last Day of Instruction	Wednesday Dec. 6
Take home exam due	Monday Dec. 11 at noon

- Introductory materials are found on Canvas at https://canvas.illinois.edu/courses/38189.

- Homework problems are distributed through Canvas under BIOE 504. You will also submit homework and receive comments and grades through this site.

Dates	Lectures and Discussions
Week 1	• Review of linear algebra (Appen A) • Introduction and review of Matlab (assignment on Canvas)
Week 2	• The measurement equation (Ch. 4.1 – 4.3) • Matrix & computational forms (Ch. 4.5 – 4.7) (Linear algebra assign.)
Week 3	• Labor day (Sept. 4) • Intro to basis decomposition, PCA (Ch. 5.1 – 5.3)
Week 4	• Fourier analysis (Ch. 5.4 – 5.6) • Fourier analysis (Ch. 5.7 – 5.9)
Week 5	• Problem discussion and Ch. 4 homework review • Power spectral analysis (Ch. 5.11 – 5.13)
Week 6	• Matrix-based Fourier analysis and eigenanalysis (Ch. 6.1 – 6.3) • Problems discussion and Ch. 5 homework review
Week 7	• Singular value decomposition (Ch. 6.5 – 6.7) • Intro to systems biology models (Ch. 6.9)
Week 8	• Problem discussion and Ch. 6 homework review • Experimental design and hypothesis testing (Ch. 8.1 – 8.2)
Week 9	• Power analysis and ROC analysis (Ch. 8.2 – 8.3) • Problem discussion and Ch. 8 homework review
Week 10	• Statistical pattern recognition in flow cytometry (Ch. 9.1 – 9.2) • Discriminant analysis and clustering (Ch. 9.3 – 9.4)
Week 11	• Problem discussion and Ch. 9 homework review • First-order linear systems of equations (Ch. 10.1-10.2)
Week 12	• Modeling cell growth (Ch. 10.3 – 10.4) • Nonlinear and linearized models: predator-prey (Ch. 10.5 -10.7)
Week 13	• Modeling infectious disease in a population (Ch. 10.8 – 10.9) • Problem discussion and Ch. 10 homework review
Week 14	Fall break
Week 15	• Second-order systems: sensors (Ch. 11.1 – 11.2) • Laplace transforms for solving ODEs (Ch. 11.3 – 11.5)
Week 16 (Dec. 7)	• Take home exam assignment due Monday Dec 11 at noon.

Assignments. Topics covered if there is time.

You can access the VPN needed to connect to Matlab at the webstore via (it's free):
https://webstore.illinois.edu/Shop/product.aspx?zpid=2600

You can also obtain a VPN through the AppStore for iPads and other Apple products.

The following websites offer hardware and software resources that might be useful to you.
https://it.engineering.illinois.edu/keeplearning

https://answers.uillinois.edu/illinois.engineering/104402

A nice college website with advice on remote learning:
https://students.grainger.illinois.edu/GFX/remote-learning/

You may use Engineering IT's Citrix Workspace to access Matlab at this site:
https://it.engineering.illinois.edu/services/instructional-services/remote-connections-citrix/remote-connections-citrix-sld

At the bottom of the page, you will find this link for connecting to Citrix:
https://it.engineering.illinois.edu/ews/lab-information/remote-connections/connecting-citrix

You need to connect to the campus VPN to use this service. Let me know if you have difficulties.

Academic Integrity

This course is designed to encourage students to cooperate with each other and collaborate in problem solving assignments. Effective collaboration is a trait of successful researchers and educators in the 21st century. Students are strongly encouraged to participate in "classroom" discussions, offer perspectives, and ask questions that foster a vital part of the learning process.

Specifically in the pandemic year of 2020, every student has a responsibility to behave safely concerning social distancing, face coverings, and adhering to campus policies related to participation in educational activities, either in-person or remote. If there is a reason you cannot attend a scheduled class meeting (in-person or remote), it is your responsibility to notify the instructor of the planned absence.

Homework assignments: You may use textbooks and electronic resources to solve HW problems, but you must give credit to those sources. This is the same requirement that must be followed when publishing in the peer-reviewed literature. Ethical practice demands that you acknowledge the contributions of others.

Take-home final exam: I ask that you NOT collaborate but work alone to solve these problems. You may use textbooks and electronic resources of your choice.

In both forms of assessment, you will need to code in Matlab. Unless you have spent considerable time coding, the computational aspects of problem solving and modeling can be time consuming. Cooperation and code sharing is acceptable and encouraged if the sharing is equitable and acknowledged in writing within each assignment.