BIOE 298MI "Mathematical Methods for Device Evaluation and Pathway Modeling"

Spring Semester 2016; 3 credit hours plus discussion hour
Instructor: Michael Insana, mfi@illinois.edu, http://ultrasonics.bioengineering.illinois.edu/courses.asp
Teaching Assistant: Cameron Hoerig, hoerig2@illinois.edu

Description: The language of systems analysis is linear algebra. Whether it is mechanical or electrical devices, cells metabolizing and communicating, or modeling other linear-system behavior with Matlab, the use of matrices is a fundamental engineering skill. This course introduces matrix methods with applications in medical instruments and systems biology that are core to bioengineering.

Class time: Tuesdays and Thursdays from 9-10:20am in 253 Mechanical Engineering Bldg.
Homework Discussion (optional) will be offered on Fridays 1-2pm in 1265 DCL.

Required Text: "Systems Biology: Linear Algebra for Pathway Modeling," H.M. Sauro, Ambrosius Publishing, 2015
http://www.amazon.com/Systems-Biology-Algebra-Pathway-Modeling/dp/0982477392/ref=sr_1_1?ie=UTF8&qid=1446126319&sr=8-1&keywords=Systems+Biology%3A+Linear+Algebra+for+Pathway+Modeling

Recommended Text: "Linear Algebra with Applications," Eighth (Alternate) Edition, 2014. Gareth Williams. Jones and Bartlett Learning Series, Burlington MA.

Other texts:

- http://linear.ups.edu/download/fcla-3.40-tablet.pdf
- https://www.math.ucdavis.edu/~linear/
- https://www.oercommons.org/search?f.search=linear+algebra (create a free login to view)
- http://www.saylor.org/site/wp-content/uploads/2012/02/Linear-Algebra-Kuttler-1-30-11-OTC.pdf

MATLAB is required for the course and can be accessed in a variety of ways:

1. EWS machines.
2. Install on your own computer, there is a site license that is free for UIUC students through the campus webstore: https://webstore.illinois.edu/home/
3. Note that EWS machines can be accessed remotely in a number of ways: https://it.engineering.illinois.edu/ews/lab-information/remote-connections

Pre- or co-requisites: Math 286 and BIOE 205 and some basic knowledge of Matlab

Grading: is based on homework 30%, two midterm exams (20% each) and a final exam (30%) given on the final exam date and time. Grades will be based on total scoring as follows: A (90-100%), A- (85-89%), B+ (80-84%), B (75-79%), B- (70-74%), C+ (65-69%), C (60-64%), C- (55-59%), D (45-54%), F (<45%).

You may check all HW and exam scores at
https://my.bioen.illinois.edu/gradebook/set.asp?subj=BIOE&crsnum=298&term=120161

Course Outline: (<2 weeks per topic, chapter number refers to Sauro book)

1. Vector fundamentals and algebra (ch 1)
2. Matrix analysis with stoichiometric examples (ch 2)
3. Systems of equations: reduced echelon form, elementary transforms, Gauss-Jordan elimination, homogeneous systems, network modeling, convolution (ch 3)
4. Determinants: minors, cofactors, matrix inverse, triangular matrices, matrix adjoint, homogeneous systems and rank (ch 4)
5. Vector spaces: R^n and C^n, linear independence, basis, dimensionality, orthogonality, null spaces (ch 5)
6. Fundamental subspaces for modeling and analyzing cellular metabolism (ch 5)
7. Eigenanalysis: eigenvalues, eigenspaces, similarity transforms (ch 6)
8. Transformations between and within vector spaces (imaging and measurement device analysis, Fourier analysis) if there is time.

Academic Calendar	
Instruction Begins	Tuesday, January 19
Spring Vacation Begins	Saturday, March 19, 1 p.m.
Instruction Resumes	Monday, March 28, 7 a.m.
Instruction Ends	Wednesday, May 4
Reading Day	Thursday, May 5
Final Examinations Begin – End	Friday, May 6 – Friday, May 13

Expectations: I expect each student to show up for every class. I will follow required text to the extent possible, but I plan to add additional topics and problems not included in the book.

Homework is due on designated Thursdays (approximately every two weeks) at 9am, beginning of class time. Late homework will not be accepted. Homework is graded on a 100-pt scale, from 0 (no HW attempted) to 100 (all problems attempted and described fully). Students are expected to study the solution sets to ensure that they have understood all of the problems assigned. Friday reviews are advised.

First two exams given during class time (based on course discussion and homework)
Final exam will be given during the scheduled final-exam time.

Class rules:

- If you must miss an exam due to unforeseen circumstances, you are required to email Prof. Insana the reason at least 24 hours before the scheduled exam time. You have 48 hours following the missed exam to submit documentation to Prof. Insana, which he will evaluate and decide whether or not to offer a makeup exam. Failure to follow this procedure will result in a zero for the exam.
- There will be instances when students must make an individual choice about their ability to perform on an exam and will need to accept any and all consequences for that choice.
- If the absence is a result of a protracted illness of 3 days or more, you should follow the procedure for obtaining a letter from the Office of the Dean of Students. The request may be made once you return to class but not more than 10 business days after the last date of absence.
- Students with DRES accommodations and student athletes must submit official paperwork and requests for accommodations during the first 10 days of class.

- Ethics and Integrity: Students are expected to uphold the highest ethical standards, be honest, and practice academic integrity. This includes doing original work and citing sources used. Group discussions with classmates, currently enrolled in the course, about course content, homework, and MATLAB assignments are encouraged. However, all work submitted by you must be your own work. Please see the University's policy on academic integrity, found in *Code of Policies and Regulations Applying to All Students* under Article One, Part IV.
- Working on course material with students who are not currently enrolled in the course is prohibited. Also, using course materials from previous semesters is prohibited. This is cheating as defined in the student code and is a violation of academic integrity.