

BME 6938: Applied Data Science for Biomedical Engineers

1. **Description:** (3 credit hour) – Advanced data science technology W/Matlab to analyze biomedical data.
2. **Pre-requisites and Co-requisites:** COP 2271 or equivalent and BME 3053L or equivalent.
3. **Course Objectives:**
 - Develop a proficiency in the use of *advanced data science technology W/Matlab* to analyze biomedical data.
 - Develop an understanding of *biomedical engineering and data analysis problems* that require advanced computational skills.
4. **Contribution of course to meeting the professional component:** 3 credit of engineering topics (no design component)
5. **Relationship of course to program outcomes:**
 - (a) Ability to apply knowledge of math, science, engineering
 - (e) Ability to identify, formulate, solve engineering problems
 - (k) Ability to use techniques, skills and tools for engineering practice
6. **Instructor:** Lin Yang
 - a. Office location: NEB 364
 - b. Telephone: 352-294-2228
 - c. E-mail address: lin.yang@bme.ufl.edu
 - d. Web site: <http://www.bme.ufl.edu/labs/yang/>
 - e. Office hours: TBA
7. **Teaching Assistant:** TBA
8. **Meeting Times:** Tuesday: 8.30AM – 11.30PM
9. **Class/laboratory schedule:** One 150 minutes session per week
10. **Meeting Location:** RNK 230
11. **Material and Supply Fees:** N/A
12. **Textbooks and Software Required**
 - a. Title: Applied Numerical Methods W/Matlab: For Engineers & Scientists
 - b. Author: Chapra, Steven
 - c. Publication date and edition: 2011, 3rd edition

d. ISBN number: 0073401102

Required software: Matlab (info.apps.ufl.edu)

13. **Recommended Reading:** see 12 above

14. **Course Outline**

| Topic | Week | Homework | Presentation |
|---|-------|----------------|----------------------|
| Introduction: Matlab Programming Environment, basic data elements in Matlab and graphics in Matlab | 01/09 | | |
| Mathematical Modeling: Numerical method, programming, round-off and truncated errors | 01/16 | | Student presentation |
| Numerical Optimization: Bracketing method and open methods, optimization without constraints | 01/23 | | Student presentation |
| Linear Algebra for Data Analysis: Matrix, vector space, inner/outer product, etc. | 01/30 | | Student presentation |
| Linear Algebra for Data Analysis: Singular value decomposition, over-determined/under-determined linear system, linear discriminant analysis | 02/06 | | Student presentation |
| Post-processing for Biomedical Data: RANSAC, robust estimation, outliers | 02/13 | Homework 1 due | Student presentation |
| Post-processing for Biomedical Data: Fourier analysis, spectrum analysis, correlation and covariance, principal component analysis | 02/20 | | Student presentation |
| Curve Fitting for Biomedical Data: Polynomial interpolation, spline fitting, robust curve fitting | 02/27 | | Student presentation |
| Integration and Differentiation: Numerical integration and differentiation, initial-value problem and adaptive methods, boundary-value problem | 03/13 | | Student presentation |
| Machine learning for Biomedical Data: Unsupervised clustering, K-means, Mean-shift | 03/20 | Homework 2 due | Student presentation |
| Machine learning for Biomedical Data: Supervised learning, support vector machine, boosting | 03/27 | | Student presentation |
| Emerging topics in Math Data Science: Markov random field, graphic models, and conditional random field and its usage in biomedical data science | 04/03 | | Student presentation |
| Emerging topics in Math Data Science: The mathematical principles of Neural Network | 04/10 | Homework 3 due | Student presentation |

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| Emerging topics in Math Data Science: The mathematics principles of Deep Convolutional Neural Network (DCNN). Why DCNN works? The wide range of biomedical applications using DCNN. | 04/17 | | Student presentation |
| BME Final Project Demonstration | 04/24 | Final software demo and presentation due. Final report due | |

15.

Attendance and Expectations: On time class attendance is expected.

Expectations:

- Be to class on time.
- no cell phone disruptions or e-device distractions.
- turn in homework on time and make legible
- better late than never
- ask for help if you need it

16. **Grading:**

45% Homework, 15% Student Presentations, 40% Final Project

Each student will be expected to give one presentation to the entire class with 25 minutes presentation and 5 minutes Q&A. We have a detailed rubric to score the students' presentations and the rubric is at the end of this document.

Final project will be a group work. It will involve a programming based project. At the final demonstration day, the students are expected to demo the results of the data analysis software. The students are also expected to give a 30 minutes presentation and also a final report with 6 pages, in a journal publication format.

17. **Grading Scale:**

- A = 94 – 100
- A- = 90 – 93.99
- B+ = 87 – 89.99
- B = 83 – 86.99
- B- = 80 – 82.99
- C+ = 77 – 79.99
- C = 73 – 76.99

C- = 70 – 72.99

D = 61 – 69.99

F = 0 – 60.99

A C- will not be a qualifying grade for critical tracking courses. In order to graduate, students must have an overall GPA and an upper-division GPA of 2.0 or better (C or better). Note: a C- average is equivalent to a GPA of 1.67, and therefore, it does not satisfy this graduation requirement. For more information on grades and grading policies, please visit:

<https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

18. **Make-up Exam Policy** – Exams can be rescheduled for an individual due to sickness or religious holidays. The instructor **must** be notified in advance. The detailed policy can be found in the following link:

<http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020%20-%20attendance#exam>

19. **Honesty Policy** – UF students are bound by The Honor Pledge which states, “We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: “On my honor, I have neither given nor received unauthorized aid in doing this assignment.” The Honor Code (<http://www.dso.ufl.edu/sccr/process/student-conduct-honor-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Note that failure to comply with this commitment will result in disciplinary action compliant with the UF Student Honor Code Procedures.

See <http://www.dso.ufl.edu/sccr/procedures/honorcode.php>

Unless otherwise stated, all homework for this class must be done individually. ***In this class it is a violation of the Academic Honesty code to obtain assistance on homework assignments from other individuals without acknowledging such.***

20. **Accommodation for Students with Disabilities** – Students Requesting classroom accommodation must first register with the Dean of Students Office. That office will provide the student with documentation that he/she must provide to the course instructor when requesting accommodation.

21. **UF Counseling Services** – Resources are available on-campus for students having personal problems or lacking clear career and academic goals. The resources include:

- UF Counseling & Wellness Center, 3190 Radio Rd, 392-1575, psychological and psychiatric services.
- Career Resource Center, Reitz Union, 392-1601, career and job search services.
- SHCC mental Health, Student Health Care Center, 392-1171, Personal and Counseling

- Center for Sexual Assault/Abuse Recovery and Education (CARE), Student Health Care Center, 392-1161, sexual assault counseling
- Career Resource Center, Reitz Union, 392-1601, career development assistance and counseling

22. **Software Use** – All faculty, staff and student of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

23. Students are expected to provide feedback on the quality of instruction in this course by completing online evaluations at <https://evaluations.ufl.edu>. Evaluations are typically open during the last two or three weeks of the semester, but students will be given specific times when they are open. Summary results of these assessments are available to students at <https://evaluations.ufl.edu/results/>.

<http://engineering.tufts.edu/cee/people/chapra/>

Student Presentation Rubric

Name:

| Category | Scoring Criteria | Total Points | Score |
|---------------------|---|--------------|-------|
| Organization | Logical sequence of information | 10 | |
| Content | Problem well defined | 10 | |
| | Technical terms well-explained | 10 | |
| | Full understanding of the topic | 10 | |
| | Well-motivated, interesting application | 10 | |
| | Use of advanced techniques | 10 | |
| | Obvious conclusion summarizing the presentation. | 5 | |
| Presentation | Maintaining eye contact and appropriately animated (e.g., gestures, moving around, etc.). | 5 | |
| | Clear, audible voice. | 5 | |
| | Delivery is poised, controlled, and smooth. | 5 | |
| | Handling of QA session | 10 | |
| | Visual aids, graphics | 5 | |
| | Time limit | 5 | |
| Score | Total Points | 100 | |

Suggestions to the presenter:

Pros:

Cons: