

## MATH 5341 - 12620 (2022 Summer 4)

### Mathematical Modeling

**Instructor:** Dr. Jiwen He, [jhe4@central.uh.edu](mailto:jhe4@central.uh.edu).

**Office Hours:** By appointment.

**Course Modality:** Online asynchronous.

**Course Platforms:** MS Teams and Blackboard.

**Course Technology Requirements:** Computer, internet, microphone and webcam.

**Textbooks:** (free download)

- [\*Introduction to Applied Linear Algebra\*](#), Boyd and Vandenberghe, Cambridge University Press, 2018

**Prerequisites:** Calculus III and Linear Algebra.

**Live Online Meetings:** The class will have optional live online meetings on Tuesday and Thursday afternoons from 5:00 PM - 7:00 PM. Students are strongly encouraged to attend the live online sessions. Notes and a video of the session will be posted for asynchronous access by students.

**Course Overview:** The course introduces vectors, matrices, and least squares methods, related topics on applied linear algebra that are behind modern data science and other applications, including document classification, prediction model from data, enhanced images, control, state estimation, and portfolio optimization. We will quickly review vectors and matrices in the first two weeks, and then focus on least squares and more advanced examples and applications in the following two and half weeks. Computations using Matlab will be part of regular assignments, and I will provide guidance and sample code. Students are expected to have basic familiarity with Matlab, but are not expected to know advanced Matlab programming. Students will not be tested over Matlab, but it will be necessary to use Matlab to complete many of the computations in the assignments.

**Discussion Forum Activity:** All students are expected to discuss the course material via the discussion forum. 10% of the final grade will be based upon discussion forum activity. Discussion forum grades will be given every week, based upon posts from the previous week. Questions are as important as answers, and even incorrect answers can receive points. **No Discussion Forum grades will be dropped.**

**Additional Communication:** Students will receive emails from the instructor a few times each week, reminding them about current material, upcoming topics, reading assignments, available help materials, and coming due dates. These emails will also be posted in a special thread within the discussion forum. Email can also be used to communicate with the instructor, although students are encouraged to use the discussion forum when the questions are not of a student specific nature.

**Written Assignments:** Written Assignments will be given several times during the semester. Students will submit their written homework by scanning and uploading their work. Instructions will be given. **One Written Assignment will be dropped** (the one with the lowest grade).

**Proctored Online Exams:** A midterm and final exam will be given. At least one of these will be proctored. If an exam is not proctored, then it will be project based. Specific information will be given during the first week of class.

**Grades:** Discussion Forum Activity – 10%, Written Homework – 20%, Midterm – 30%, Final Exam – 40%. Important Note: Students must score at least 50% on the final exam to pass the course (which will not be a problem for anyone keeping up and doing their own work in the course). The grading scale is standard: 94–100 (A), 90–93 (A-), 87–89 (B+), 84–86 (B), 80–83 (B-), 77–79 (C+), 74–76 (C), 70–73 (C-), 67–69 (D+), 64–66 (D), 60–63 (D-), 0–59 (F).

**Whenever possible, and in accordance with 504/ADA guidelines, we will attempt to provide reasonable academic accommodations to students who request and require them.**

**Counseling and Psychological Services (CAPS)** can help students who are having difficulties managing stress, adjusting to college, or feeling sad and hopeless. You can reach ([CAPS](#)) by calling 713-743-5454 during and after business hours for appointments or if you or someone you know is in crisis. No appointment is necessary for the “[Let’s Talk](#)” program, a drop-in consultation service at convenient locations and hours around campus.

### **Course Topic Outline and Tentative Schedule**

- Part 1 - Vectors (1 week, July 11 - July 15 )
  - Linear functions, Taylor approximation, regression model
  - Norm, distance, angle, standard deviation, and correlation
  - Clustering, the k-means algorithm, and applications
- Part 2 - Matrices (1 week, July 18 - July 22)
  - Geometric transformations, selectors, incidence matrix, and convolution
  - Linear dynamical systems, population dynamics, epidemic dynamics, motion of a mass, supply chain dynamics
- Part I3 - Least Squares (2.5 weeks, July 25 - August 8)
  - Least squares data fitting, validation, feature engineering
  - Least squares classification, least squares classifier, and multi-class classifiers
  - Multi-objective least squares, control, estimation and inversion, regularized data fitting
  - Constrained least squares, portfolio optimization, linear quadratic control, and linear quadratic state estimation