# MAE 289A: Mathematical Analysis for Applications

**Instructor:** Sonia Martínez, EBU-I 1807, 858-822-4243, soniamd@ucsd.edu

**Lecture Time and Place:** Tu - Th: 3:30pm to 4:50pm.

**Teaching Assistant:** Parth Paritosh, pparitosh@ucsd.edu

**Office Hours:** Mon 3:30pm to 4:30pm, Wed from 3:00 to 4:00pm. Zoom links will be made available.

**Texts:** The following are some references for the course, although any book in mathematical and discrete analysis should be useful:

D. Solow. *How to read and do proofs.* John Wiley and Sons, 2014, sixth edition

K. Rosen. *Discrete mathematics and its applications.* McGraw-Hill, 2012

W. Rudin. *Principles of Mathematical Analysis.* McGraw-Hill, Inc., 3 edition, 1964

Buying these books is not necessary, concise notes will be provided during the course lectures.

**Course Objectives:** This course is the first one of a series of three, covering miscellaneous topics of mathematical reasoning, discrete mathematics, topology in Euclidean spaces, convergence of sequences/series, properties of real/vector-valued functions of one and/or several variables, and functional analysis.

Currently, the level of mathematics necessary for a successful path through much of the MAE PhD graduate curriculum is above that with which engineering students typically arrive with. The goals of this sequence of courses is to develop a student's mathematical maturity—your ability to understand and create mathematical arguments to solve problems—as well as to provide some basic background in discrete and real analysis mathematics. While doing so, we will aim to present applications of the theory to algorithms, dynamic systems, optimization, and control.

The topics to be covered in 289A are included among the following:

- Logic and proofs. Proof methods and strategies to constructing proofs. Conjectures. Application to algorithm analysis.
- Sets, and set operations. Set cardinality. Metric spaces. Open and closed sets, compact sets. Connected Sets (Euclidean topology.)
- Sequences and series; sequences defined by mappings. Convergent sequences (limits). Subsequences. Supremum and infimum. The fixed point theorem and the contraction principle. Applications to optimization, game equilibrium seeking (applications to value iteration and policy iteration.)
- (Partially, time permitting). Continuity of functions. Compactness and continuity. Continuity and connectedness. Uniform continuity. Lipschitz continuity. Convexity. Applications to Lyapunov analysis, and optimization algorithms.

**Course websites:**

http://nodes.ucsd.edu/sonia/teaching/mae289a-F2021/

The website above just contains the most basic course information. A canvas website will contain course videos and notes. Piazza is now available via canvas. Please refer to the canvas website for for updates and other important announcements related to the course.

**Class participation:** It is important that you participate and attend the synchronous course lectures as much as possible. I would like to ask each student to ask actively questions during lectures, as well as actively participate in piazza. Piazza participation is rewarded with an extra 3% of the grade (for 4 endorsed questions in Piazza.)

**Grading:** The final course grade will be calculated as follows:

- Participation in class/piazza: extra 3%
- Homework: 80%
- Final: 20 %

**Assignments:** Homework assignments are the main load of this course, which focus on analytical problems. In addition, we will hold a final exam (comprehensive, take-home exam). Homework will be posted on the canvas course website. All assignments are to be submitted via Canvas through gradescope.

**Late homework policy**: Only one late homework is allowed with no penalty. All other homework that is turned in late (by one day) will be counted up to 85%. If you turn homework later than this, and until the solutions are posted, the hw will drop to 30%. If several late assignments are turned in late, I will take the one with the highest score for the full grade computation.

**Collaboration policy:** You are encouraged to work with other students on your homework, and to help other students complete their assignments, provided that you comply with the following conditions:

1. Honest representation: The material you turn in for course credit must be a fair representation of your work. You are responsible for understanding and being able to explain and duplicate the work you submit.
2. Active involvement: You must ensure that you are an active participant in all collaborations, and are not merely dividing up the work or following along while another student does the work. For example, copying another student's work without actively being involved in deriving the solution is strictly prohibited.
3. Work individually or in small groups: Working in groups of more than **three** people is discouraged because it limits the amount of participation by each member of the group. In your homework solutions please indicate the names of the people you collaborated with. Please write your own homework solutions.
4. Give help appropriately: When helping someone, it is important not to simply give them a solution, because then they may not understand it fully and will not be able to solve a similar problem next time. It's always important to take the time to help someone think through the problem and develop the solution. Often, this can be accomplished by asking them a series of leading questions.
5. If in doubt, ask your instructor: Be sure to ask in advance if you have any doubts about whether a certain type of collaboration is acceptable

**Academic integrity:**

No form of academic dishonesty will be tolerated. For the definition of academic dishonesty and its consequences refer to the Student Conduct Code available at the UCSD website.

It is essential that all assignments for this course be completed in accordance with the precepts of the Code of Academic Integrity. Failure to comply with the Code of Academic Integrity will not be tolerated.

**Students with disabilities:** Students requesting accommodations for this course due to a disability must provide a current Authorization for Accommodation (AFA) letter issued by the Office for Students with Disabilities (OSD) which is located in University Center 202 behind Center Hall. Students are required to present their AFA letters to Faculty (please make arrangements to contact me privately) and to the OSD Liaison in the department at least **two weeks prior to an exam** to ensure that accommodations may be arranged.

Please contact the OSD for further information:
T: 858.534.4382
E: `osd@ucsd.edu`
W: `http://disabilities.ucsd.edu`

**Dealing with problems:** Recall that you may consult with the office of Counseling and Phychological Services (CAPS) in campus about a variety of personal, academic and relationship problems. No problem or concern is too big or small to do this. For more information on the CAPS services please visit `https://wellness.ucsd.edu/CAPS/about/Pages/default.aspx`