Syllabus for
MATH 485: Mathematical Modeling
Spring 2020
(Revised on March 19, 2020 due to COVID-19 public health crisis)

Lecture Hours: Tuesdays and Thursdays: 11am – 12:15pm
Classroom: Online via Zoom (link: https://arizona.zoom.us/j/241738655)
Textbook: Mathematical Modeling, Joceline Lega
(Textbook and additional course materials will be provided at no cost to the students)
Course Website: http://math.arizona.edu/~calvinz/math485_s20.html
Instructor: Professor Calvin Zhang-Molina, Ph.D.
Email: calvinz@math.arizona.edu
Office Hours: Tuesdays 2 – 4pm (online via Zoom using the same link above)
Project Mentors: Dr. Christina Duron duronc@math.arizona.edu
Dr. Alex Farrell alexpfarrell@math.arizona.edu
Bill Fries frieswd@math.arizona.edu
Will Gammel wgammmel@math.arizona.edu
Phil Hoskins phoskins@math.arizona.edu
Jared McBride jaredm@math.arizona.edu
Zihan Zhu zihanzhu@math.arizona.edu

Course Objectives:
(1) Understand what is mathematical modeling, its merits, and limits;
(2) learn the theory and techniques needed to construct a simple mathematical model using differential equations, probability theory, and/or statistical theory;
(3) learn how to analyze your mathematical model analytically (using mathematical theories and techniques) and numerically (using numerical methods and computer simulations);
(4) learn how to test and refine your mathematical model using existing data and knowledge;
(5) learn how to interpret the results of your mathematical model in the context of the problem;
(6) learn how to work with peers in a collaborative environment; and
(7) learn how to communicate effectively your results, in both written format and through oral presentations, to not only the academic audience but also the general public.

Expected Learning Outcomes:
(1) Be able to read, understand, and summarize the main findings of interdisciplinary literatures involving mathematical models;
(2) be able to work collaboratively and positively in a team environment;
(3) be able to construct, analyze, and simulate simple mathematical models with deterministic and/or stochastic elements;
(4) understand the basic theories and techniques in
   (i) dynamical systems theory (bifurcation analysis and numerical methods),
   (ii) simple probabilistic models and their computer simulation,
   (iii) basic line search methods, conjugate gradient methods, KKT condition, least square problems, linear programming (the simplex method) in continuous optimization;
   (iv) integer programming, shortest paths problem;
(v) linear regression, logistic regression, and nonlinear transforms;
(5) be able to summarize the findings from your mathematical model in a clear and organized
written report; and
(6) be able to speak clearly, effectively, and efficiently about your mathematical findings to a
general audience.

**Prerequisites:** In addition to Calculus I, Calculus II, and Vector Calculus, this course also
requires completion of (1) at least one 400-level MATH course (422, 454, 456, or 475A), (2) Linear
Algebra, (3) Differential Equations, and (4) a programming course.

**Absence and Class Participation Policy:** You are expected to attend every scheduled class.
Please communicate with me in advance if you know you will miss a class, especially a quiz or
a team presentation. If you are not finding class time valuable for any reason, please let me
know; I would rather hear your feedback than wonder why you are not in attendance. Excessive
or extended absence from class is sufficient reason for you to be administratively dropped from
the course. In particular, if you miss the first two class meetings or have a total of three or more absences
from class meetings over the semester, you may be administratively dropped. It is your responsibility to
keep informed of any announcements, syllabus adjustments, or policy changes made during
scheduled classes. UA policy on Class Attendance, Participation, and Administrative Drops:
catalog.arizona.edu/policy/class-attendance-participation-and-administrative-drop. Absences
for any sincerely held religious belief, observance or practice will be accommodated where
reasonable: policy.arizona.edu/human-resources/religious-accommodation-policy. Absences
pre-approved by the UA Dean of Students (or Dean Designee) will be honored:
deanofstudents.arizona.edu/absences.

**Homework & Quizzes:** There will be regular homework assignments and in-class quizzes.
Homework assignments will be posted online at the course website. The in-class quizzes are
given in class during regular lecture hours. Problems in the quizzes are based on previous
homework assignments. The instructor will be expecting you to express your ideas completely,
clearly and legibly. This means you could lose points for incomplete, ambiguous or sloppy
answers. **Due to the rapidly developing COVID-19 public health crisis, starting on March 19, all future
in-class quizzes are cancelled, and instead, your homework scores (starting with Homework Set 5) will
substitute for the in-class quiz scores.**

**No Make-Up Quizzes or Late Homework:** To be fair to everybody in this class, no make-up
quizzes or late homework submissions are allowed unless you have extreme hardship of
long duration. Note, however, your lowest three scored quiz/homework items will be dropped
in your course grade calculation. This policy is designed to provide great flexibility to all
students while ensuring fairness and equality.

**Team Projects:** You will work in teams on a semester-long project. Each team will give two oral
presentations, an initial presentation in the first half of the semester and a midterm presentation
in the second half of the semester. In addition, each team will turn in a midterm written report
and a final written report, and will present a poster in a poster session held in a public venue.
Here is a list of projects for this semester:

- **Project A:** Control Theory - Glycolytic Oscillation
- **Project B:** Neurophysiology - Coordination of Limbs
- **Project C:** Stochastic Processes - Neurotransmitter Release
- **Project D:** Data Analysis - Instant Decision for Credit Card Applications
Project E: Probability Theory - Investment Portfolio Selection
Project F: Dynamical Systems - Cancer Cell Growth and Treatment

Each team will be assigned a Project Mentor. Project Mentors are math graduate students in or postdoctoral researchers who have volunteered to provide you with guidance and advice on your project throughout the semester. For more details on these projects, see: math.arizona.edu/~calvinz/math485_s20_projects.html

Grading Criteria: The course grade will be determined by an absolute scale with a slight modification if appropriate. An approximate guideline is: 90% - 100% = A; 80% - 89% = B; 70% - 79% = C; 60% - 69% = D; Less than 60% = E. Each component of your graded work will be counted into your course grade with the following weight factors:

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-Class Quizzes &amp; Homework*</td>
<td>50%</td>
</tr>
<tr>
<td>Initial Reading and Essay</td>
<td>5%</td>
</tr>
<tr>
<td>Initial Team Project Presentation (oral)</td>
<td>5%</td>
</tr>
<tr>
<td>Midterm Team Project Report (written + oral)</td>
<td>20%</td>
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<tr>
<td>Final Team Project Report (written + poster)</td>
<td>20%</td>
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</tbody>
</table>

(* The lowest three scored quiz/homework items will be dropped from course grade calculation to accommodate unexpected situations.) University policy regarding grades and grading systems is available at catalog.arizona.edu/policy/grades-and-grading-system

Request for Regrade: A request for regrade will be accepted if a written request is submitted to the instructor within seven calendar days after graded papers are returned. In your written request, please explain: (1) what part of the exam should be regraded; and (2) why it should be regraded.

Code of Academic Integrity: Students are encouraged to share intellectual views and discuss freely the principles and applications of course materials. However, graded work/exercises must be the product of independent effort unless otherwise instructed. Students are expected to adhere to the UA Code of Academic Integrity as described in the UA General Catalog. See: https://deanofstudents.arizona.edu/policies/code-academic-integrity

Classroom Behavior Policy: Students and faculty each have responsibility for maintaining an appropriate learning environment. Students who fail to adhere to behavioral standards may be subject to discipline. Faculty have the professional responsibility to treat students with understanding, dignity and respect, to guide classroom discussion and to set reasonable limits on the manner in which students express opinions. Disruption, as applied to the academic setting, means behavior that a reasonable faculty member would view as interfering with normal academic functions. Examples include, but are not limited to: use of cellphone in class; persistently speaking without being recognized or interrupting other speakers; behavior that distracts the class from the subject matter or discussion; or in extreme cases, physical threats, harassing behavior or personal insults, or refusal to comply with faculty direction. Civil expression of disagreement with the course instructor, during times when the instructor permits discussion, is not in itself disruptive behavior and is not prohibited.

UA Nondiscrimination and Anti-harassment Policy: The University is committed to creating and maintaining an environment free of discrimination; see http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy. Our classroom is a place where everyone is encouraged to express well-formed opinions and their reasons for those opinions.
We also want to create a tolerant and open environment where such opinions can be expressed without resorting to bullying or discrimination of others.

**Threatening Behavior Policy:** The UA Threatening Behavior by Students Policy prohibits threats of physical harm to any member of the University community, including to oneself. See [http://policy.arizona.edu/education-and-student-affairs/threatening-behavior-students](http://policy.arizona.edu/education-and-student-affairs/threatening-behavior-students).

**For Veteran Students:** This instructor is a Vet Ally. Vet Allies advocate for military-connected students by listening to their stories, recognizing their capabilities, and connecting them to campus resources, such as UA’s Veterans Education and Transition Services (VETS). VETS is an organization run by veterans, spouses, dependents, and current service members who through their shared experiences endeavor to maintain a dynamic and effective program which is responsive to the needs of our community. VETS recognizes shifting from the military to the academic environment is not always a straightforward process and is committed to providing a safe and supportive environment that makes this transition from military to student to employed graduate as smooth as possible. If you have questions, please feel free to talk to the instructor directly, or contact VETS at 520-626-8380 or vetsofc@email.arizona.edu, or visit one of the two VETS centers on campus.

**Accessibility and Accommodations:** At the University of Arizona, we strive to make learning experiences as accessible as possible. If you anticipate or experience barriers based on disability or pregnancy, please contact the Disability Resource Center (520-621-3268, [https://drc.arizona.edu](https://drc.arizona.edu)) to establish reasonable accommodations.

**Communication with the Instructor:** Due to the large volume of emails he receives, the instructor may not be able to respond to your emails on time. Therefore, please use the time before and after the class meeting for a short communication. You are most welcome to visit his office during the office hours (see page 1 for his office location and office hours).

**Schedule of Topics and Activities:**

<table>
<thead>
<tr>
<th>Date</th>
<th>Topic</th>
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<tbody>
<tr>
<td>Jan 16 — Feb 4</td>
<td>Continuous, deterministic models and their computer simulation</td>
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<tr>
<td>* Feb 6</td>
<td>* In-class team activity</td>
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<tr>
<td>Feb 11</td>
<td>Initial Team Project Oral Presentation</td>
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<tr>
<td>Feb 13 — Mar 3</td>
<td>Stochastic models and their computer simulation</td>
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<tr>
<td>Mar 5</td>
<td>* In-class team activity</td>
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<tr>
<td>Mar 10 &amp; 12</td>
<td>Spring break (no class)</td>
</tr>
<tr>
<td>Mar 17 &amp; 19</td>
<td>Midterm Team Project Oral Presentation</td>
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<td>(Written Midterm Report due on Thur, Mar 26)</td>
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<tr>
<td>Mar 24 — Apr 2</td>
<td>Continuous and discrete optimization and numerical methods</td>
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<tr>
<td>Apr 7</td>
<td>* In-class team activity</td>
</tr>
<tr>
<td>Apr 9 — Apr 30</td>
<td>Machine learning methods</td>
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<tr>
<td>May 5</td>
<td>* In-class team activity</td>
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Information contained in the course syllabus, other than the grade and absence policy, may be subject to change with reasonable advance notice, as deemed appropriate by the instructor.