<table>
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<tr>
<th><strong>Course #:</strong></th>
<th>CPS 5310 CRN 21295 and CPS 6310 CRN 27488</th>
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<tbody>
<tr>
<td><strong>Course title:</strong></td>
<td>Mathematical and Computer Modeling</td>
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<td><strong>Credit hours:</strong></td>
<td>3</td>
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<td><strong>Term:</strong></td>
<td>Spring 2023</td>
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<td><strong>Time &amp; Location:</strong></td>
<td>1:30-2:50 pm TR, Old Main 205</td>
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<td><strong>Prerequisites:</strong></td>
<td>Calculus III (MATH 2313), Matrix Algebra (MATH 3323), and Introduction to Computational Science (CPS 5401) with a grade of B or better; or permission of the instructors.</td>
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<td><strong>Course fee:</strong></td>
<td>None</td>
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<td><strong>Instructors:</strong></td>
<td>Natasha Sharma and Ming-Ying Leung</td>
</tr>
</tbody>
</table>
| **Office location:** | Sharma: Bell Hall Room 318  
Leung : Bell Hall Room 225 |
| **Contact information:** | **Sharma:**  
Office phone: 915-747-6858  
Email: nssharma@utep.edu  
[https://natasha-shilla-sharma.github.io/](https://natasha-shilla-sharma.github.io/)  
**Leung:**  
Email: mleung@utep.edu  
Office phone: 915-747-6836  
[http://www.math.utep.edu/Faculty/mleung](http://www.math.utep.edu/Faculty/mleung) |
| **Office hours:** | Sharma: 3:00-4:00 pm, TR  
Leung: Posted weekly at [www.math.utep.edu/Faculty/mleung/officehours](http://www.math.utep.edu/Faculty/mleung/officehours) |
| **Teaching assistant:** | TBA |
| **TA office location:** | TBA |
| **TA email:** | TBA |
| **TA office hours:** | TBA |
Additionally, sections of the following online books will also be used:  
Victor Eijkhout, Introduction to High-performance Scientific Computing  
Cleve Moler, Numerical Computing with Matlab, 2004  
Course Description
Computer simulation of selected practical problems from physics, engineering, geology, biology, or chemistry. Students learn to create mathematical models formulate modeling assumptions, select appropriate numerical methods, implement them in the form of a computer program, and visualize the numerical results. Emphasis is given to verification and validation procedures.

Grading
Your grade for the course will be based on the following:
- 50% homework (including labs)
- 40% midterms and final exam
- 10% class preparation and participation

Attendance Policy
Lecture attendance is required and noted at the beginning of class; more than two unexcused absences will result in an instructor-initiated drop and/or final grade reduction. Your academic/research advisor will be consulted before final action is decided and taken. It is the student’s responsibility to cover the topics missed during this absence.

Tardiness Policy
There is a zero-tolerance policy for tardiness in this class. Besides the fact that showing up late disrupts the entire class, tardiness is a personal reflection of being unprofessional and lacking time management skills. To this end, no students will be permitted in the class after the first five minutes of the lecture time have passed. Furthermore, students who miss these lecture will be responsible to cover the topics missed. If you anticipate potentially being late, please email your instructor ideally 24 hours before the lecture and the instructor will try to provide accommodations accordingly.

Homework Policy
Homework will be assigned on a regular basis. There will be approximately 8-10 assignments during the semester. Homework will need to be turned in through Blackboard or Bitbucket (whenever specified).
Once the announcement of the homework is made, it is the student’s responsibility to make sure they understand the assigned task and make clarifications if needed well before the deadline for submission. This clarification should be made preferably via email or during lecture time or during office hours.
The grades of the homework and exams will be made via Blackboard. It is the student’s responsibility to look at the awarded numeric grades as soon as possible and carefully go over the grading of the assignment.
There is a 2-week "statute of limitations" for students to contact the instructor/grader on matters related to the grading of a specific assignment. This 2-week deadline is counted from the day of the grade notification.
Accommodations for Students with Disabilities
If you have a disability and need classroom accommodations, please contact The Center for Accommodations and Support Services (CASS) at 747-5148, or by email to cass@utep.edu, or visit their office located in UTEP Union East, Room 106. For additional information, please visit the CASS website at www.sa.utep.edu/cass.

Academic Honesty Policy
Make sure you understand the UTEP academic honesty policy. Students are encouraged to share ideas, but you must do your own homework and you must write your own code for the projects (you may copy code that is on the course website). If homework or program code is suspected of being duplicated or copied, you will receive an incomplete for the assignment, and your case will be referred to the Dean of Students for adjudication. If the instructor has reason to believe that you have cheated on a quiz or exam, your case will be referred to the Dean of Students for adjudication.

Course Format and Participation
The lecture portion of the class will consist of short lectures interspersed with hands-on interactive activities. Lab assignments will reinforce the lecture material. The lecture and lab exercises will make use of CPS Program Linux lab machines, the UTEP Research Cloud, and the Stampede Supercomputer at the Texas Advanced Computing Center. Students should be able to log in to these resources remotely from a home or office computer. All students should bring a laptop computer to class with which to log in to the remote resources. (Please let the instructors know if you do not have a laptop you can bring to class).

Course Topics
The following is a list of topics to be discussed. The exact schedule may vary depending on the previous background of the class participants.

1. Principles of mathematical modeling [textbook Chapter 1]
   - steps of modeling and simulation
   - mixture problem
   - linear programming
   - phenomenological and mechanistic models
   - classification of mathematical models
   - using the computer algebra software Maxima

2. Mechanistic models I: ODEs [textbook Chapter 3]
   - setting up ODE models
   - first-order ODEs
   - autonomous, implicit, and explicit ODEs
   - Initial Value Problem
   - Boundary Value Problems
systems of ODEs
numerical solutions
Fitting ODEs to Data

3. Mechanistic models II: PDEs [textbook Chapter 4]
   - theory of PDEs
   - numerical solution of PDEs (finite difference and finite element methods)
   - examples (material science applications, structural mechanics)

4. High-Performance Mathematical Software
   - software for ODEs
   - software from PDEs

5. Phenomenological models [Introduction to Probability Models, Chapters 1, 2, & 4]
   - Introduction to probability theory
   - Random variables
   - Markov chains

Term project (if applicable)
The term project will consist of:
1. development and solution of a mathematical model for a physical problem not discussed in class nor assigned for homework
2. a report describing the background for the model, model definition, simulation method, results, and validation
3. a presentation describing and demonstrating your model,
4. model definition, simulation method, results, and validation
The specific problem can be of your choosing but you must have your topic pre-approved by the instructor. You may work individually on the final project or in teams of up to three people. In the case of group work, you must document the contributions of each team member and carry out the amount and difficulty of the work proportional to the size of your team.

Learning Outcomes
After completing this course, students should be able to

1. DESCRIBE the major approaches to mathematical modeling
2. DEFINE an appropriate mathematical model for a physical problem
3. DESIGN and IMPLEMENT a solution strategy for a mathematical model
4. VALIDATE the results of a mathematical model
5. FORMULATE and SOLVE mechanistic models of physical systems using ODEs
6. FORMULATE and SOLVE mechanistic models of physical systems using PDEs
7. DESIGN and IMPLEMENT solutions to models in a scientific programming language
CPS 5310 Syllabus, Computational Science, UTEP

8. APPLY mathematical software to solve large-scale models on high-performance computer systems
9. FORMULATE stochastic models for describing systems with uncertainty
10. APPLY probabilistic techniques to predict and assess outcomes in random processes