THE UNIVERSITY OF TEXAS AT EL PASO  
COLLEGE OF SCIENCE  
COMPUTATIONAL SCIENCE PROGRAM

<table>
<thead>
<tr>
<th>Course #:</th>
<th>CPS 5310</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course title:</td>
<td>Mathematical and Computer Modeling</td>
</tr>
<tr>
<td>Credit hours:</td>
<td>3</td>
</tr>
<tr>
<td>Term:</td>
<td>Spring 2021</td>
</tr>
<tr>
<td>Time &amp; location:</td>
<td>1:30-2:50pm TR, Virtually through Zoom/Blackboard Collaborate.</td>
</tr>
<tr>
<td>Prerequisites:</td>
<td>Calculus III (MATH 2313), Matrix Algebra (MATH 3323), and Introduction to Computational Science (CPS 5401) with grade of B or better; or permission of the instructors.</td>
</tr>
<tr>
<td>Course fee:</td>
<td>None</td>
</tr>
<tr>
<td>Instructors:</td>
<td>Natasha Sharma and Suneel B Chatla</td>
</tr>
</tbody>
</table>
| Office location:  | Sharma: Bell Hall Room 318  
|                   | Chatla: Bell Hall Room 227  |
| Contact information: | Sharma: Office phone: 915-747-6858  
|                   | Email: nssharma@utep.edu  
|                   | http://www.math.utep.edu/Faculty/nsharma/public_html/teaching.html  
|                   | Chatla: Email: sbchatla@utep.edu  
|                   | Office phone: 915-747-6764  |
| Office hours:     | Sharma: TBA  
|                   | Chatla: 3:00-3:30 pm TR  |
| 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
- 10% class preparation and participation

Attendance Policy

Lecture attendance is required and noted at the beginning of class; more than a total of TWO unexcused absences will result in an instructor-initiated drop or final grade reduction. Your academic/research advisor will be consulted before final action is decided and taken.

Although attendance will not be taken, please try not to be absent unless absolutely necessary.

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 online lectures interspersed with hands-on interactive activities. Lab assignments will reinforce the lecture material. Students should be able to login to these resources remotely from a home or office computer. All students should have access to a laptop or a Desktop. The first five weeks will focus on the Stochastic part of Mathematical Modeling taught by Dr. Chatla and the remainder of the course is focused on the Mechanistic part of Mathematical Modeling taught by Dr. Sharma. There will be 2 midterms and one final exam all of which are compulsory.

Course Topics

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

1. Principles of mathematical modeling [textbook Chapter 1]
   - steps of modeling and simulation
   - classification of mathematical models
   - using the computer algebra software Maxima

2. Phenomenological models [textbook Chapter 2]
   - descriptive statistics
   - random processes and probability
   - inferential statistics
   - linear regression
   - nonlinear regression
   - using calc and R

3. 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 solution of ODEs

4. Mechanistic models I: ODEs [textbook Chapter 4]
   - theory of PDEs
   - numerical solution of PDEs (finite difference and finite element methods)
   - examples (flow in porous media, computational fluid dynamics, structural mechanics)

5. High-Performance Mathematical Software
   - software for ODEs
   - software from PDEs (C++ Library deal.II and Fortran Library PDE2D)

Learning Outcomes
After successfully 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. APPLY regression models to analyze datasets
6. FORMULATE and SOLVE mechanistic models of physical systems using ODEs
7. FORMULATE and SOLVE mechanistic models of physical systems using PDEs
8. DESIGN and IMPLEMENT solutions to models in a scientific programming language
9. APPLY mathematical software to solve large-scale models on high-performance computer systems