Computational Mechanics

ME 3255 Spring 2020

Github page: https://github.uconn.edu/rcc02007/Computational_Mechanics/

JupyterHub server: https://compmech.uconn.edu/

Course Description

This course introduces students to computational methods in Python. Computational methods, best programming practices, and version control are introduced. These methods will be applied to a number of physics-based problems.

This is a project-based introduction to computational mechanics. There are five modules with exercises, homeworks, and final projects. The overall goal of the course is learn to frame engineering problems as computational methods. Once we can communicate our engineering problems to Python code (or any other computer language) we can use standardized computational methods to solve those problems.

Course Expectations

Students are expected to create numerical approximations for linear and nonlinear problems, understand approximations due to floating point operations and numerical approaches and solve differential equations using numerical differentiation and integration. Students are also expected to learn basics of git version control, Python functions and programming best practices.

Lectures: TTh 9:30-10:45 AM, MCHU rm 301

Lab times: TTh 9:30-10:00 AM and 10:15-10:45 AM, EII rm 202

Instructor: Prof. Ryan C. Cooper (ryan.c.cooper@uconn.edu)

Office hours: MW 9:00-11:00 AM in EII rm 314

Teaching Assistants:

- Graduate: Bhushan Patil bhushan.patil@uconn.edu
- Office hours: TBD in EII 202

Course Information

Prerequisite: CE 3110, MATH 2410Q

Tools used: Python, Jupyter , git, and Github

Required Resources:

- Computational Mechanics materials are a combination of work from Prof. Ryan C. Cooper at the University of Connecticut Mechanical Engineering Department and the Engineering Computations Modules from Prof. Lorena A. Barba and doctoral student Natalia C. Clement at the George Washington University, Mechanical and Aerospace Engineering Department.
- Jupyter Hub server at compmech.uconn.edu is an interactive Jupyter notebook server. We will use it with Python to run our code, create documentation, and save assignments
- UConn's Github uconn.github.edu UConn hosts its own server of the popular code-sharing website <github.com>. If you prefer to keep your work private, you can create private repositories and share them with myself and the TA

Minimum Technical Skills:

- Ability to follow coding tutorials

- Comfortable executing code in a prompt
- Comfortable working in a web browser
- Draw free body diagram and write equations of motion
- Draw a control volume and write conservation of energy equations
- Take derivatives and integrals of functions

Recommended Resources:

- Youtube: A hands-on Intro to Python for beginning programmers
- RealPython tutorials, getting started: realpython.com/start-here/
- Markdown Cheatsheet: www.markdownguide.org/cheat-sheet
- *Python for Everybody: Exploring Data Using Python 3* (2016). Charles R. Severance. PDF available
- *Think Python: How to Think Like a Computer Scientist* (2012). Allen Downey. Green Tea Press. PDF available

Recommended Textbooks:

- Chapra, Steven, *Applied Numerical Methods with MATLAB for Engineers and Scientists* 4th edition.
- Kiusalaas, Jaan, *Numerical Methods in Engineering with Python 3* Cambridge University Press (2013).

Grading

Item	Percent	Requirement
Participation	30 %	Complete the notebook exercises and discussion questions
Homework	30 %	Complete the end-of-notebook problems
Projects	40 %	Complete the module project and submit to Github

Note on Participation

You will have 30 minutes twice a week to work in the computer lab with me. I expect you to come to the lab with exercises and discussions complete. For the exercises/discussions that you have questions, I expect you to prepare some questions to help me help you understand the material. You will submit a pdf of your completed notebook at the end of the lab session time.

Note on Homeworks

The homework assignments are the problem sets at the end of each notebook. You do not have to complete these during the lab session time. They will be due before the next lab.

Academic Integrity:

- The instructors of this class have a zero-tolerance policy for academic misconduct, that is copying others' work either in the lab, field, or on an exam. Any student work that is found to be in violation of the university policy regarding academic misconduct will be assigned a grade of zero at a minimum.
- Read and understand The UConn Student Code of Conduct. Students will follow all University regulations concerning the final exam.

Course Schedule (which is subject to change based upon feedback and pace of course)

Date	Subject/Notebook	Module
Tue (01-21)	Welcome!	___NEW [Lecture01 -
Introduction](https://github.uconn.edu/rcc02007/Computational_Mechanics/blob/master/docs/me3255S2020_syllabus.pdf)		
Thu (01-23)	01_Interacting_with_Python	Getting-Started
Tue (01-28)	02_Working_with_Python	Getting-Started
Thu (01-30)	03_Numerical_error	Getting-Started
Tue (02-04)	Module 1 Project	Review and submit
Thu (02-06)	meet MCHU 301-Review	**Lecture**
Tue (02-11)	01_Cheers_Stats_Beers	Analyze Data
Thu (02-13)	02_Seeing_Stats	Analyze Data
Tue (02-18)	03_Linear_Regression_with_Real_Data	Analyze Data
Thu (02-20)	04_Stats_and_Montecarlo	Analyze Data
Tue (02-25)	module 2 Project	Review and submit
Thu (02-27)	01_Catch_Motion	Initial Value Problems
Tue (03-03)	02_Step_Future	Initial Value Problems
Thu (03-05)	03_Get_Oscillations	Initial Value Problems
Tue (03-10)	04_Shooting_solutions	Initial Value Problems
Thu (03-12)	Module 3 Project	Review and submit
Tue (03-17)	Spring Break!!	R&R
Thu (03-19)	Spring Break!!	R&R
Tue (03-24)	meet MCHU 301-Review	**Lecture**
Thu (03-26)	01_Solving_equations	Linear Algebra
Tue (03-31)	02_Gauss_elimination	Linear Algebra
Thu (04-02)	03_Linear_regression_revisited	Linear Algebra
Tue (04-07)	Catch-up day	Linear Algebra
Thu (04-09)	Module 4 project	Review and Submit
Tue (04-14)	01_Finite_differences	Boundary Value Problems
Thu (04-16)	02_Solutions_in_1D	Boundary Value Problems
Tue (04-21)	03_Solutions_in_2D	Boundary Value Problems
Thu (04-23)	Catch-up day	Boundary Value Problems
Tue (04-28)	Review course material	**Lecture**
Thu (04-30)	Module 5 project	Review and Submit