CE 5331 Computational Skills for Engineers

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Office Hours: Please email for an appointment. In addition to face-to-face, office hours can be conducted virtually via Teams or Zoom.

Course Rationale: Engineers often take a computer programming course early in their undergraduate studies but seldom use it extensively through their curriculum.

Many graduate level courses such as numerical methods and finite elements require students to be proficient in programming. Programming proficiency is critical for modern machine learning.

These courses are perceived to be hard as many graduate students have to learn both programming skills as well as concepts presented in the class resulting in a cognitive overload that results in a sub-optimal student experience.

Purpose: The purpose of this class is to provide a skills-based introduction to programming that is aimed at early graduate students.

The course uses the popular programming language Python and introduces the student to both traditional and modern tools that are useful for them in their research and professional practice. The course makes use of 'real-world' datasets and state-of-the-art programming technologies.

The course will be taught in a hybrid classroom format with Asynchronous lectures

While geared toward Civil Engineers. The course should be of interest to Mechanical, Industrial, Petroleum, Chemical engineers and other applied science disciplines

Instrument	Weight	Remarks
Quizzes	20%	Quizzes will be on online LMS
Mini Projects	40 %	4 Mini-Projects
Homework Assignments	40%	Will entail both coding and reading assignments (~8)

The instructor reserves the right to change the proposed content and grading structure depending upon the evaluation of the progress of the class as well as changes brought forth by unforeseen circumstances and changes in programming and engineering practices.

Tentative Outline

Topic #	Contents	Remarks
Topic 1	Course Introduction	course preliminaries
Topic 2	Install Python and Anaconda	First Python program
Topic 3	Python Datastructures	
Topic 4	Reading Data into Python using Pandas	Intro to. Object-Oriented Python
Topic 5	Control statements in Python	Intro to Python structural programming
Topic 6	User Defined Functions in Python	
Topic 7	Matrices and Arrays in Python	Numpy Library
Topic 8	Graphing & Visualization in Python	Matplotlib and Seaborn libraries
Topic 9	Vectorization and Parallel Computing	Multithreading and multiprocessing libraries (Pandas and Numpy)
Topic 10	Optimization and Regression in Python	Scipy and other libraries
Topic 11	Integrations and ODEs	Numerical and Symbolic calculus
Topic 12	Python and GIS	Geopandas, Rasterio, GDAL
Topic 13	Text Mining in Python	Unstructured Data Mining in Python
Topic 14	Physical Computing using Python	Integration of Python + sensors
Topic 15	Python - Web Deployment	Flask, Dash

As the course is asynchronous you can, to a large extent, work at your own pace but need to meet certain milestones to ensure you are making satisfactory progress. Initial topics should generally take less time (esp. topics 1 - 3) and some topics will require more than normal time (esp. topics 7 onwards).

The course is structured in a bootcamp format and intended to provide an introduction to several tasks that can be performed using Python. The selection of topics is geared towards helping students take CE5310: Numerical Methods in Engineering, CE 5315: Probabilistic Methods for Civil Engineers and CE 5319: Machine Learning for CIvil Engineers.
The topics covered is not exhaustive but provides a broad coverage of both fundamental and cutting-edge topics. The more you practice the better you will be at Python Programming.