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# Math 893: Scientific Computational Lab

## Solving Differential Equations with Python Tools

Fall 2022

Department of Mathematical Sciences, UWM

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### Lecture Time and Place

4:30 PM - 6:25 PM, Wednesday, EMS 424A.

### Instructor

Prof. Dexuan Xie

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Office Hours: 10:30 - 11:30 AM, Monday and Wednesday (Canvas visual classroom).

### Textbook

- *Solving PDEs in Python: The FEniCS Tutorial I*, Hans Peter Langtangen and Anders Logg, Springer Open on the website  
<https://link.springer.com/content/pdf/10.1007%2F978-3-319-52462-7.pdf>.

### Prerequisite

Math 715 with grade over C or contact the instructor for permission.

### Course Overview

In this course, we study Python programming techniques and software packages for solving partial differential equations (PDEs) by the finite element method. Students are supposed to have basic Python programming skills. They are also required to have their own computers (in OSX, Windows, or Linux) so that they can install the programming tools and software packages. The following topics will be covered:

- Introduction of Python programming tools: *Jupyter notebook* and *PyCharm*. You need to install at least one of them on your personal computer before the class. Both are the IDEs for Professional Data Scientists to program in Python.
- Advanced object-oriented programming techniques in Python classes: *Composite numerical integration schemes; linear iterative and nonlinear iterative methods (like SOR and Newton's method) for solving Poisson boundary value problems; and explicit and implicit Euler's methods for solving time-dependent initial and boundary value problems (such as the Poisson-Nernst-Planck equations)*.
- *FEniCS* finite element package for solving PDEs in Python: *There are two versions of FEniCS: FEniCSx and legacy FEniCS. Both can be downloaded from*

*the webpage: <https://fenicsproject.org/download/>. The legacy FEniCS (version 2019.1.0) will be used in this class since the programs of the textbook are written via this version. But, you are encouraged to learn FEniCSx too.*

None of exams and projects are given. Students are only required to complete four homework assignments and to present their homework results in the class.

## **Grading**

- Four homework evaluations: 70 %. Each 17.5 %.
- Two homework presentations: 20 %. Each 10 %.
- Attendance: 10 %
- Grading scale: A (90-100), A- (84-89), B (75-83), C (65-74), D (55-64), F (below 55)

## **Important Dates**

- September 7: First class
- September 19: Last day to add class
- October 3: Last day to drop without a "W" on academic record
- November 13: Last day to drop or withdraw from full-term classes
- November 23 - 27: Thanksgiving Break - No classes
- December 14: Last day of the class
- December 23: Last day of the term.

## **Attendance:**

Attendance is required. Attendance will be taken after the first week. Each class missing is resulted in one point reduction. There is no provision for absences, missing homework, and missing the final report due to vacations, family outings, social activities, or other special plans and appointments, etc. Absences due to illness require medical excuse on Physician's letterhead, signed by a physician.

## **Discussion:**

Homework discussions will be held for students to present their homework results. Each student needs two presentations to earn the discussion points.

## **Homework:**

Doing homework well is essential to be successful in this class. The homework will be assigned in the class. Students are required to complete all the homework assignments. Some homework problems will be discussed in class. Each homework must be submitted online before the submission deadline date.

## **Statement of Academic Misconduct**

Students are responsible for the honest completion and representation of their work. Further information can be found at

[http://www4.uwm.edu/acad\\_aff/policy/academicmisconduct.cfm](http://www4.uwm.edu/acad_aff/policy/academicmisconduct.cfm).