Syllabus of Numerical Solutions of Differential Equations
Fall 2020, 3.0 credits,

Time and place: 周二第8、9、10节(14:55-17:30); 玉泉校区教11-417.
Instructor: 张庆海 (`qinghai@zju.edu.cn`)
Website: `http://www.mathweb.zju.edu.cn:8080/teacher_intro.asp?userid=329`
Teaching Assistant: 朱玉可 (`yukezhu0323@126.com`)

Prerequisites: (1) numerical analysis, (2) linear algebra, and (3) proficiency of programming in `C++`.

Description: This course concerns numerical methods for solving differential equations. Topics include:

(a) Geometric multigrid methods for linear elliptic equations.

(b) Fundamentals of finite difference (FD) and finite volume (FV) methods.

(c) Numerical methods for solving ordinary differential equations.

(d) FD/FV methods for solving hyperbolic equations.

(e) FD/FV methods for solving parabolic and other partial differential equations.

One main theme of this class is the combination of mathematical theory and software engineering. Therefore, **this course will contain a truckload of `C++` programming and emphasize the interdisciplinary collaboration of computer science and mathematics**.
In order to survive in this class (and probably also in your own graduate research), you will have to utilize a number of essential tools such as LaTeX, `emacs`, `auxtex`, `GNU make`, `cmake`, `blas`, `lapack`, `gdb`, ...

Reference books:
There is no official textbook for this class; for most of the time I will write on the blackboard and a student is supposed to take notes and tell her own story in pdf files typeset by LaTeX. But most contents in this class can be found in the following books.

1) *A Multigrid Tutorial* by W. L. Briggs, V. E. Henson, and S. F. McCormick, second edition, SIAM, 2000, ISBN: 0-89871-462-1
2) *Numerical Solutions of Differential Equations* by Z. Li, Z. Qiao, T. Tang, first edition, Cambridge University Press, 2018, ISBN: 978-1-107-16322-5.
3) *Finite Difference Methods for Ordinary and Partial Differential Equations: Steady-State and Time-dependent Problems* by R. LeVeque, first edition, SIAM, 2007, ISBN: 978-0898716290.
4) *Numerical Methods for Ordinary Differential Equations* by J. C. Butcher, third edition, Wiley, 2016, ISBN: 978-1119121503.

Homework and projects: There will be a homework assignment every one or two weeks, but most of the time your homework solutions will not be graded. Instead, you organize what you've learned in solving homework problems, in attending lectures, in reading reference books, and in your own thinking into a pdf file for each of the topics (a-e). You are supposed to turn in one pdf file of your own story, which will be graded.
There will be a number of programming assignments through which you can build your skills of software engineering and improve your ability of solving problems. These programming assignments will be graded and discussed.

Programming: Programming is an essential part of this class. All programming assignments are required to be done in `C++`. You may program with up to one partner; you and your partner will get the same grade for the programming part of any project.

Grading:
The details will be announced around midterm.

Extra credit: I encourage the students to think actively and to study hard. As rewards, extra credit will be given to those who

- correctly answer extra-credit questions posed in class;
- correctly solve extra-credit problems after class;
- bring to my attention any typos and mistakes I made either on the blackboard or in handouts.

Warnings:
I have zero tolerance of academic dishonesty!
If the sole purpose of your taking this class is to get three credits, I strongly recommend that you drop this class. However, if you work through this class with courage, curiosity, and diligence, chances are high that you will learn a LOT!