

Syllabus of Numerical Solutions of Differential Equations

Spring 2023, 3.5 credits,

Time and place: 周一第3、4、5节(10:00-12:25), 周二第9节(16:15-17:00); 紫金港北3-312.

Instructor: 张庆海 (qinghai@zju.edu.cn)

Teaching Assistant: 胡双; 颜嘉图 (NumPDEs@163.com)

Prerequisites: (1) numerical analysis, (2) linear algebra, (3) basis analysis, (4) ordinary differential equations, and (5) C++ programming experience.

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

- (a) Finite difference (FD) methods for solving boundary value problems.
- (b) Numerical methods for solving ordinary differential equations.
- (c) Fundamentals of and finite volume (FV) methods.
- (d) FD/FV methods for solving hyperbolic, parabolic and incompressible Navier-Stokes equations.
- (e) Finite element methods (FEMs) for solving boundary value problems.

One main theme of this class is the combination of mathematical theory and software engineering, as the main objective of this class is to help you cultivate the ability of solving realworld problems with math and computers.

I strongly encourage you to utilize a number of essential tools such as L^AT_EX, emacs, AucTex, GNU make, cmake, blas, lapack, gdb,

Reference books:

There is no official textbook for this class; I will write my own notes. 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) *Solving Ordinary Differential Equations I: Nonstiff problems* by E. Hairer, S. P. Norsett, and G. Wanner, second revised edition, Springer, 1993, ISBN: 978-3-540-56670-0.
- 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.

Homework and projects: There will be a homework assignment every one or two weeks, but not all of your homework solutions 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.

Grading: Homework and programming assignments accounts for 40% of your final score while the final exam for the other 60%.

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 the 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!