
Math 815: Numerical Methods for Differential Equations

Spring 2022

Department of Mathematical Sciences, UWM

Lecture Time

4:30 PM - 7:10 PM, Wednesday, EMS Building, Room E495

Instructor:

Professor Dexuan Xie

Office: EMS, Room W411

Telephone: (414) 229-5103

E-mail: dxie@uwm.edu

Homepage: www.uwm.edu/~dxie

Office Hours: 10:00 AM - 11:00 AM, Monday and Wednesday

Reference Books

- *Numerical solution of partial differential equations by the finite element method*, Claes Johnson, Cambridge, 1987, **ISBN-13: 978-0486469003**
- *Solving PDEs in Python*, 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>.
- *Numerical Analysis*, Richard L. Burden and J. Douglas Faires, Thomson, Brooks/Cole, 10th Edition, 2016.

Prerequisite

Graduate standing; Math 715(P); or consent of instructor.

Course Overview

Lectures are given in Instructor's teaching notes based on the textbooks. Homework assignments consist of theoretical problems, numerical experiments, and programming problems in Python. This course will be delivered in face-to-face format. Assignments will be distributed via Canvas.

The following topics will be covered:

- **Initial value problems for ordinary differential equations:** Euler's method, higher-order Taylor methods, Runge-Kutta methods, multistep methods, variable step size strategies, convergence, and stability analysis.
- **Boundary value and initial value problems for elliptic and parabolic partial differential equations:** Finite difference method, variational formulation, and finite element methods for Poisson equation, heat equation, nonlinear Poisson equation, and a system of advection-diffusion-reaction equations.

- **Iterative and preconditioning techniques for solving large scale sparse linear systems:** Successive-over-relaxation (SOR) method, conjugate gradient method, preconditioned conjugate gradient method, symmetric Gauss-Seidel preconditioner, symmetric SOR preconditioner, and incomplete LU preconditioner.

Grading

- Four homework evaluations: 60 %. HW1 for 15 %, HW2 for 15 %, HW3 for 15 %, and HW4 for 15 %.
- Discussion: 10 %
- Final Exam: 30 %
- Grading scale: A (93-100), A- (88-92), B+ (83-87), B (78-82), C+ (73-77), C (65-72), D (55-64), F (below 55)

Important Dates

- _ January 24: First day of classes.
- _ February 20: Last day to drop without "W" on academic record.
- _ March 20-27: Spring Break.
- _ April 10: Last day to drop.
- _ May 9: Last day of classes.
- _ May 16: **Final Exam:** 3:00-5:00 PM on EMS E423.

Homework Policies

Homework is assigned in class. It is required to be done on a notebook. You must copy the problems and describe your solutions in detail. The due dates are announced one week earlier in class. Late homework will not be accepted. Collaboration among students is allowed but each student must submit his/her own work.

Discussion

Homework discussions will be held on selected problems. Each student needs at least two presentations on his/her work to earn the discussion points.

Class 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 examination, and missing homework 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.

Makeup Policies

No makeup is given for the final exam, but an incomplete grade can be given to eligible students (e.g., missed for religious observance, military service, or illnesses (with a documented medical emergency)).

Additional Information

- Texting and photo-taking are not permitted during class time. Cell phones and smart watches should be turned off.
- Books, notes, and calculators/computers are NOT allowed in the final exam.
- Room changes and cancellations are valid only if posted outside the classroom door on Math Department letterhead and sent via email.
- Students with disabilities or who qualify for accommodations (VISA) should contact me early in the semester to discuss the assistance they may need.

Statement of Academic Misconduct

The university has a responsibility to promote academic honesty and integrity and to develop procedures to deal effectively with instances of academic dishonesty. Students are responsible for the honest completion and representation of their work, for the appropriate citation of sources, and for respect of others' academic endeavors. Further information can be found at

<http://uwm.edu/academicaffairs/facultystaff/policies/academic-misconduct/>.

Other important university policies

They can be found here: <https://uwm.edu/secu/wp-content/uploads/sites/122/2016/12/Syllabus-Links.pdf>