

## MATH 574 NUMERICAL SOLUTIONS FOR PDE I

**Section:** 01      **Quarter:** Spring 2024      **Classroom:** IESB 228, 10 a.m.– 11:50 a.m. TR

**Instructor:** Dr. Weizhong Dai      **Office:** Nethken Hall 233      **E-Mail:** dai@coes.latech.edu

**Office Hours:** 1:15 p.m. – 4:15 p.m., W; 1:00 p.m. – 4:30 p.m., Tu, Th      **Phone:** 257-3301

**Web Site:** [www2.latech.edu/~dai/](http://www2.latech.edu/~dai/)

**Course Prerequisites:** Math 407, or consent of instructor

**Course Goals:**      The instructor will present and test a subset of these topics (see the attached contents)

**Textbook:**      W. Dai, A. Khaliq, and R. Nassar, *An Introduction to Finite Element Method*, Van-Griner Learning, Cincinnati, Ohio, 2020.

### Attendance

**Regulation:**      Read the “Class Attendance” section in the Tech Bulletin which says in part that “Class attendance is ... an obligation ... and all students are expected to attend regularly and PUNCTUALLY.”  
Class attendance will be used in determining grades.

**Homework Policy:**      Homework will be assigned after lectures. There are two collections, one after test 1 and the other after test 2.

**Examinations:**      Two tests will be given during this session.

### Grade Determination

**Procedure:**      Test 1 40%, Test 2 45%, HW 15%

**Students Needing Special Accommodations:** Students needing testing or classroom accommodations based on a disability should discuss the need with the instructor during the first week of class. Any issues with accessing technology, which are related to a disability, should be reported to the instructor as soon as possible.

**Honor Code:** In accordance with the Academic Honor Code, students pledge the following: Being a student of higher standards, I pledge to embody the principles of academic integrity. For details refer to <http://www.latech.edu/tech/students/honor-code.pdf>.

**Emergency Notification System:** All Louisiana Tech students are strongly encouraged to enroll and update their contact information in the Emergency Notification System. It takes just a few seconds to ensure you're able to receive important text and voice alerts in the event of a campus emergency. For more information on the Emergency Notification System, please visit.

<http://www.latech.edu/administration/ens.html>

**COVID-19 related information:**

- a. Students can access COVID-19-related information, guidelines, FAQs, and policies at Louisiana Tech's website: <https://www.latech.edu/coronavirus/>.
- b. Louisiana Tech's Return to Campus Plan is located at <https://www.latech.edu/coronavirus/return-to-campus-plan/>. The university will follow guidelines as established by the UL-system which may change at any time. Consistent with current policy, at this time: Masks are not required to be worn indoors on campus for those who have no symptoms or have been cleared to return to campus without a mask.
- c. The direct link to the reporting protocol for students is located at <https://www.latech.edu/coronavirus/return-to-campus-plan/for-students/>. Students can reach out to Stacy Gilbert, Dean of Student Services & Academic Support, at [stacyc@latech.edu](mailto:stacyc@latech.edu) for help with accommodations and additional information.
- d. Failure to comply with the Safety Protocols as described on the university website, could result in students being in violation of the Classroom Behavior Policy listed on page 125 of the Student Handbook <https://www.latech.edu/documents/2018/09/student-handbook.pdf>.
- e. Information and contact numbers and sites for Louisiana Tech Counseling Services are located at: <https://www.latech.edu/current-students/student-advancement-affairs/counseling-services/>.

# **Contents and Tests**

## **Chapter 1. Preliminaries**

1. Equations of Mathematical Physics (introduction)
2. Fourier Series Method (brief)
3. Finite Difference Method (brief)
4. Numerical Solution using FDM
5. Computational Techniques for Solving Linear System
  - (1) Thomas algorithm
  - (2) Point iterative methods
  - (3) Conjugate gradient method
  - (4) FORTRAN codes

## **Chapter 2. Mathematical Principles for FEM**

1. Formulas, Spaces, Lemma
2. Weak Form Problems
3. Solution of Weak Form Problem (Galerkin method)

## **Test 1 (Chapters 1 and 2)**

## **Chapter 3. Finite Element Method**

1. Linear element for 1D elliptic equation problem
2. Triangular element for 2D Poisson equation
  - (1) Triangular mesh and linear basic function
  - (2) Set up a linear system based on the Galerkin method
  - (3) Assembly for obtaining coefficient matrix
3. Linear and Triangular elements for 1D, 2D heat conduction problems
  - (1) Set up a system of solution based on the Galerkin method for 1D problem
  - (2) Set up a system of solution based on triangular mesh for 2D problem
4. Rectangular element
  - (1) Rectangular element for 2D Poisson equation
  - (2) Rectangular element for 2D heat conduction problem
5. Higher degree 1D basis functions
6. Higher degree 2D basis functions

## **Test 2 (Chapter 3)**