

MATH 610 Numerical Partial Differential Equations

Fall 2022 — Section 600

Lecture: TR 3:55pm – 5:10pm, Blocker 160

Lab: W 12:40pm – 1:30pm, Blocker 124

Lecturer: Dr. Matthias Maier

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Office: Blocker 502C

Office hours: W 1:30pm - 2:30pm, or by appointment

Website: <https://www.math.tamu.edu/~maier/math610.html>

Prerequisites: MATH 417, or MATH 609, or equivalent; knowledge of computer programming.

Lab: Jordan Hoffart,

<https://jordanhoffart.github.io/teaching.html>

Textbook: Lecture notes will be made available online

(optional) *Numerical Treatment of Partial Differential Equations*, Grossmann, Ross, Stynes, Springer, 2007. Available online

<https://libcat.tamu.edu/vwebv/holdingsInfo?searchId=24040&recCount=10&recPointer=1&bibId=2992761>

(optional) *Theory and Practice of Finite Elements*, Ern, Guermond, Springer, 2004.

Catalogue Description: Introduction to finite difference and finite element methods for solving partial differential equations; stability and convergence of methods and error bounds.

Course overview and learning outcomes:

- This is a one-semester course on numerical methods for partial differential equations. The course will focus on basic concepts of the finite element method for elliptic boundary value problems. Topics include: the weak (variational) formulation of prototypical problems, coercivity and continuity arguments, inf-sup conditions, approximation theory of finite elements, error analysis, stability, and a discussion of variational "crimes".
- Further, some basic techniques of finite differences and finite volumes will be introduced and discussed. Maximum principle, energy type estimates, and Fourier mode analysis will be used for studying the stability and accuracy of these methods applied to elliptic, parabolic and hyperbolic problems. The intention is to develop a fairly strong mathematical knowledge and expertise so that after completing the class the students can read and understand quite advanced papers on finite element methods for PDEs (and partially for finite differences, and finite volumes). The programming assignments will emphasize applications of the numerical techniques to engineering problems.
- Though this course covers the numerical analysis part of the qualifying exam in ApplMath/NA it is intended mainly for engineering students. I recommend the Spring term for math students who will try to pass ApplMath/NA qualifier.

Course assessment:

- Two midterm exams, either to be held on **Thu Sept 29**, and **Thu Nov 10** during class, or alternatively as a take-home midterm.
- The final exam is scheduled for **Tue Dec 13, 1:00-3:00pm**.
- There will be 10 homework assignments due in the weeks of Thursday **Sept 1, 8, 15, 22, Oct 13, 20, 27, Nov 3, 17, Dec 1**. The two lowest homework scores will be dropped. Homework will not be accepted late. Homework has to be submitted via canvas either as scanned, or as typeset pdf.
- There will be 6 programming assignments due in the weeks of Thursday **Sept 8, 22, Oct 13, 27, Nov 17, Dec 1**. The lowest programming assignment score will be dropped.

Exams (and make-up policy): One sheet of handwritten notes (one-sided letter page) can be brought to each exam. Calculators may be needed. Make-ups for exams will only be given if you can provide a documented University-approved excuse. According to *University Student Rules* you are required to notify the instructor by the end of the next working day after missing an exam. Otherwise you forfeit your right to a make-up. See <http://student-rules.tamu.edu/rule07> for the full university policy.

Grading: The final grade will be determined from the following weightings: Programming assignments (25 %), homework (25 %), midterms (15 % + 15 %), final exam (20 %). Earning 90 %, 80 %, 70 %, or 60 % of the total points will result in a final letter grade of A, B, C, or D, respectively, though, the boundaries between grades may be relaxed (in your favor) at the lecturer's discretion.

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COVID-19 Statement: To help protect Aggieland and stop the spread of COVID-19, Texas A&M University urges students to be vaccinated and to wear masks in classrooms and all other academic facilities on campus, including labs. Doing so exemplifies the Aggie Core Values of respect, leadership, integrity, and selfless service by putting community concerns above individual preferences. COVID-19 vaccines and masking - regardless of vaccination status - have been shown to be safe and effective at reducing spread to others, infection, hospitalization, and death.

Attendance Policy: The university views class attendance and participation as an individual student responsibility. Students are expected to attend class and to complete all assignments. Please refer to Student Rule 7 in its entirety for information about excused absences, including definitions, and related documentation and timelines.

Makeup Work Policy: Students will be excused from attending class on the day of a graded activity or when attendance contributes to a student's grade, for the reasons stated in Student Rule 7, or other reason deemed appropriate by the instructor. Please refer to Student Rule 7 in its entirety for information about makeup work, including definitions, and related documentation and timelines. Absences related to Title IX of the Education Amendments of 1972 may necessitate a period of more than 30 days for make-up work, and the timeframe for make-up work should be agreed upon by the student and instructor (Student Rule 7, Section 7.4.1). The instructor is under no obligation to provide an opportunity for the student to make up work missed because of an unexcused absence (Student Rule 7, Section 7.4.2). Students who request an excused absence are expected to uphold the Aggie Honor Code and Student Conduct Code. (See Student Rule 24).

Scholastic Dishonesty: Students are strongly encouraged to work together and discuss homework problems with each other. However, copying work done by others, either in-class or out of class, is an act of scholastic dishonesty. Plagiarism has serious consequences in real life (up to and including loss of jobs and careers), and you will likewise receive no credit for assignments in this course if you are caught plagiarizing.

Academic Integrity Statement and Policy: “*An Aggie does not lie, cheat or steal, or tolerate those who do.*” Texas A&M University students are responsible for authenticating all work submitted to an instructor. If asked, students must be able to produce proof that the item submitted is indeed the work of that student. Students must keep appropriate records at all times. The inability to authenticate one’s work, should the instructor request it, may be sufficient grounds to initiate an academic misconduct case” (Section 20.1.2.3, Student Rule 20). You can learn more about the Aggie Honor System Office Rules and Procedures, academic integrity, and your rights and responsibilities at <https://aggiehonor.tamu.edu>.

Americans with Disabilities Act (ADA) Policy Statement: Texas A&M University is committed to providing equitable access to learning opportunities for all students. If you experience barriers to your education due to a disability or think you may have a disability, please contact Disability Resources in the Student Services Building or at (979) 845-1637 or visit <https://disability.tamu.edu>. Disabilities may include, but are not limited to attentional, learning, mental health, sensory, physical, or chronic health conditions. All students are encouraged to discuss their disability related needs with Disability Resources and their instructors as soon as possible.

Title IX and Statement on Limits to Confidentiality: Texas A&M University is committed to fostering a learning environment that is safe and productive for all. University policies and federal and state laws prohibit gender-based discrimination and sexual harassment, including sexual assault, sexual exploitation, domestic violence, dating violence, and stalking.

With the exception of some medical and mental health providers, all university employees (including full and part-time faculty, staff, paid graduate assistants, student workers, etc.) are Mandatory Reporters and must report to the Title IX Office if the employee experiences, observes, or becomes aware of an incident that meets the following conditions (see University Rule 08.01.01.M1): (i) The incident is reasonably believed to be discrimination or harassment. (ii) The incident is alleged to have been committed by or against a person who, at the time of the incident, was (1) a student enrolled at the University or (2) an employee of the University.

Mandatory Reporters must file a report regardless of how the information comes to their attention – including but not limited to face-to-face conversations, a written class assignment or paper, class discussion, email, text, or social media post. Although Mandatory Reporters must file a report, in most instances, a person who is subjected to the alleged conduct will be able to control how the report is handled, including whether or not to pursue a formal investigation. The University’s goal is to make sure you are aware of the range of options available to you and to ensure access to the resources you need.

Students wishing to discuss concerns in a confidential setting are encouraged to make an appointment with Counseling and Psychological Services (CAPS).

Students can learn more about filing a report, accessing supportive resources, and navigating the Title IX investigation and resolution process on the University’s Title IX webpage, <https://titleix.tamu.edu/>.

Statement on Mental Health and Wellness: Texas A&M University recognizes that mental health and wellness are critical factors that influence a student’s academic success and overall wellbeing. Students are encouraged to engage in proper self-care by utilizing the resources and services available from Counseling & Psychological Services (CAPS). Students who need someone to talk to can call the TAMU Helpline (979-845-2700) from 4:00 p.m. to 8:00 a.m. weekdays and 24 hours on weekends. 24-hour

emergency help is also available through the National Suicide Prevention Hotline (800-273-8255) or at suicidepreventionlifeline.org.

Classroom decorum: Students are expected to be attentive and courteous during class. During class, please put away any newspapers and portable music devices (walkman). Knitting is prohibited.