**Syllabus**

**Applied Mathematics & Statistics 553.483/683**  
**Numerical Methods for Partial Differential Equations**  
**Spring, 2024**  
*(4 credits, EQ)*

**Description**  
We discuss numerical methods for solving partial differential equations, explaining how solution methods must be appropriate to the mathematical structure of the equation. Specific topics will be Hyperbolic PDEs (CFL stability condition, characteristics, convergence, nonlinear conservation laws, shock capturing), Parabolic PDEs (boundary conditions, explicit and implicit discretizations, consistency, stability, and convergence, operator splitting), Elliptic PDEs (iterative methods, variational formulations). We shall focus mainly on finite-difference schemes, but other methods such as finite element, finite volume, spectral methods, Chebyshev polynomials, etc. may be discussed as time permits. All numerical methods will be illustrated with Matlab scripts.

**Prerequisites**  
The course EN.553.385 or an equivalent computing background. EN.553.480, EN553.680 or their equivalent are strongly recommended, but not required. A good introductory course in the mathematics of partial differential equations would also be helpful, but this material will be reviewed as necessary.

**Instructor**  
Professor Gregory Eyink, eyink@jhu.edu, http://www.ams.jhu.edu/~eyink  
Office hours: ??? and by appointment

**Teaching Assistant**  
Lowen Peng, lpeng22@jhu.edu  
Office hours: ????, Office: https://jhubluejays.zoom.us/j/????

**Meetings**  
Lectures: Tuesday, Thursday, 3:00–4:15pm, Hodson 316, https://wse.zoom.us/j/99699500921

**Textbook**  
We will cover the following chapters in more or less detail, and supplemented with some additional material:

- Chapter 1: Hyperbolic Partial Differential Equations
- Chapter 2: Analysis of Finite Difference Schemes
- Chapter 3: Order of Accuracy of Finite Difference Schemes
- Chapter 5: Dissipation and Dispersion
- Chapter 6: Parabolic Partial Differential Equations
- Chapter 7: Systems of Partial Differential Equations in Higher Dimensions
- Chapter 12: Elliptic Partial Differential Equations and Difference Schemes
- Chapter 13: Linear Iterative Methods
- Chapter 14: The Method of Steepest Descent and the Conjugate Gradient Method
Online Resources

Webpage: Please point your browser to [http://www.ams.jhu.edu/~eyink/NumPDE](http://www.ams.jhu.edu/~eyink/NumPDE) for all assignments, solutions, and lecture handouts. Occasionally, the website will also be used to provide reminders and additional information. (Typically this info will also be transmitted to the class via email.) Please check the website frequently for updates.

Piazza: This term we will be using Piazza for class discussion. The system is highly catered to getting you help fast and efficiently from classmates, the TA, and myself. Rather than emailing questions to the teaching staff, I encourage you to post your questions on Piazza. If you have any problems or feedback for the developers, email team@piazza.com.

Find our class signup link at: [https://piazza.com/jhu/spring2024/??????](https://piazza.com/jhu/spring2024/??????)

Canvas: We use Canvas to submit all assignments. Panopto recordings of all lectures will also be available there for asynchronous viewing. Go to [https://jhu.instructure.com](https://jhu.instructure.com)

Course Expectations & Grading

Grading: The student’s final grade will be based upon homework and exams. The breakdown will be:

<table>
<thead>
<tr>
<th>Item</th>
<th>Percent of Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework</td>
<td>50%</td>
</tr>
<tr>
<td>Midterm Exam</td>
<td>25%</td>
</tr>
<tr>
<td>Final Exam</td>
<td>25%</td>
</tr>
</tbody>
</table>

Throughout the semester the following grading rule will be used:

<table>
<thead>
<tr>
<th>Letter Grade</th>
<th>Percent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-/A/A+</td>
<td>90-100%</td>
</tr>
<tr>
<td>B-/B/B+</td>
<td>80-89%</td>
</tr>
<tr>
<td>C-/C/C+</td>
<td>70-79%</td>
</tr>
<tr>
<td>D-/D/D+</td>
<td>60-69%</td>
</tr>
<tr>
<td>F</td>
<td>0-59%</td>
</tr>
</tbody>
</table>

Homework: Homework will consist of problems covering material up to 2 days before the due date. Please review the Homework Submission Guidelines below. Homework cannot be accepted for credit after solutions have been posted on-line. If a homework is missed and there is a valid excuse, then it will be removed from the student’s total grade for the course, and the remainder of the homework assignments re-weighted.

Exams: The Final Exam will be cumulative, but focused primarily on the material covered since the Midterm. There is no senior option for this course. In case of illness or other emergency, the exam will be removed from the student’s total grade for the course, and the remainder re-weighted accordingly. Proper documentation of the emergency must be presented before this option can be offered.

Attendance: Students are not formally penalized for missing lectures/sections. However, it is the student’s responsibility to arrange to obtain notes for any missed classed and to turn in any homework due on the date of the missed class. Although participation in online discussion at Piazza will not be graded, statistics of participation by each student will be monitored and may play a role deciding grades in borderline cases.

Homework Submission Guidelines

Please make sure your name is on your homework submission. Please write neatly. The unreadable is ungradable. Please submit your problems in the order they appear on the assignment sheet. Please make sure to show all work and document any assumptions you are making. If you use special computer software (e.g., MATLAB, Python, Excel, etc.) to complete your homework/project, please read, and adhere to, the Software Usage Guidelines (see below). Homework is due by 5pm Eastern US time on the posted date unless otherwise instructed.
Software Usage Guidelines
You may use any applicable software to do homework assignments, e.g. MATLAB, Python, Excel, etc. Please include all relevant codes as executable files, which should be uploaded with written work to Canvas. The answers from the computer must include the requisite amount of explanation. Unless specifically instructed otherwise, you may use symbolic computation software for theoretical problems, but again you must include printouts of relevant code.

Key Dates
Key dates (exams, etc.) are at http://www.ams.jhu.edu/~eyink/NumPDE/schedule.html

Assignments & Readings
Reading assignments also at http://www.ams.jhu.edu/~eyink/NumPDE/schedule.html Dates given there are only approximate, and will vary somewhat from year to year.

Ethics
The strength of the university depends on academic and personal integrity. In this course, you must be honest and truthful. Ethical violations include cheating on exams, plagiarism, reuse of assignments, improper use of the Internet and electronic devices, unauthorized collaboration, alteration of graded assignments, forgery and falsification, lying, facilitating academic dishonesty, and unfair competition.

In addition, the specific ethics guidelines for this course are:

1. If you work in a group you must write up your solutions separately. Anything that looks too much like someone else’s work is likely to be considered cheating. Such assignments will receive a grade of zero and you may be subject to other disciplinary action.
2. If you work in a group on coding for homework, the group cannot create a joint computer printout and copy it for all group members. Even if you work in a group, you must still do the software work yourself and turn in your own output.
3. You are free to use any online material (books, articles, Wikipedia pages, etc.) to assist you in the solutions of homework, but any such material must be cited in your submission with an appropriate reference (e.g. url). If material is taken without credit from an online (or any other) source, it will be considered plagiarism.
4. If the midterm or final exam are given as take-homes (which will be decided by class vote), then you must attest in writing that you have not been assisted by any classmate, friend or family member.

You can find more information about university misconduct policies on the web at these sites:

- Undergraduates: http://studentaffairs.jhu.edu/student-life/student-conduct/resources-conduct-ethics/
- Graduate students: https://homewoodgrad.jhu.edu/academics/policies/

Report any violations you witness to the instructor. You can also contact:

- For undergraduates: the director of student conduct (or designee) by calling the Office of Student Conduct at 410-516-2509 or via email at studentconduct@jhu.edu
- For KSAS Graduate Students: rseitz5@jh.edu
- For WSE Graduate Students: christinekavanagh@jhu.edu

Personal Wellbeing

- The university has instituted COVID-19 vaccination requirements for our community. At present there is no indoor masking requirement or testing requirement of faculty, staff, or students. General information about COVID-19 related policies at the university can be found at these sites:
  - University COVID information: https://covidinfo.jhu.edu
  - Whiting School of Engineering: https://engineering.jhu.edu/covid-19
- If you are sick please notify me by email so that we can make appropriate accommodations should this affect your ability to attend class, complete assignments, or participate in assessments. The Student Health and Wellness Center is open and operational for primary care needs. If you would like
to speak with a medical provider, please call 410-516-8270, and staff will determine an appropriate course of action. See also https://studentaffairs.jhu.edu/student-life/student-outreach-support/absences-from-class/illness-note-policy

- Johns Hopkins University values diversity and inclusion. We are committed to providing welcoming, equitable, and accessible educational experiences for all students. Students with disabilities (including those with psychological conditions, medical conditions, and temporary disabilities) can request accommodations for this course by providing an Accommodation Letter issued by Student Disability Services (SDS). Please request accommodations for this course as early as possible to provide time for effective communication and arrangements. For further information or to start the process of requesting accommodations, please contact Student Disability Services at Homewood Campus, Shaffer Hall #101, call: 410-516-4720, email: studentdisabilityservices@jhu.edu or visit the website https://studentaffairs.jhu.edu/disabilities
- If you are struggling with anxiety, stress, depression, or other mental health related concerns, please consider visiting the JHU Counseling Center. If you are concerned about a friend, please encourage that person to seek out their services. The Counseling Center is located at 3003 North Charles Street in Suite S-200, and can be reached by phone 410-516-8278 and online at http://studentaffairs.jhu.edu/counselingcenter

Student Outreach & Support helps students manage physical and mental health concerns, personal and family emergencies, financial issues, and other obstacles that may arise during their college experience. Students can self-refer or refer a friend who may need extra support or help getting connected to resources. To connect with SOS, please visit this website: https://studentaffairs.jhu.edu/student-life/student-outreach-support or email deanofstudents@jhu.edu, call 410-516-7857, or students can schedule to meet with a Case Manager by visiting the SOS website and filling out a referral form online.

The Johns Hopkins University Behavioral Health Crisis Support Team (BHCST) pairs experienced, compassionate crisis clinicians with specially trained public safety officers on every shift on and around the Homewood campus, seven days a week. The BHCST will provide immediate assistance to those who need it and, just as importantly, link individuals in crisis to ongoing support services in the days and weeks that follow. Call Public Safety, 410-516-5600, and ask for a BHCST clinician.

Classroom Climate

I am committed to creating a classroom environment that values the diversity of experiences and perspectives that all students bring. Everyone here has the right to be treated with dignity and respect. I believe fostering an inclusive climate is important because research and my experience show that students who interact with peers who are different from themselves learn new things and experience tangible educational outcomes. Please join me in creating a welcoming and vibrant classroom climate. Note that you should expect to be challenged intellectually by me, the TAs, and your peers, and at times this may feel uncomfortable. Indeed, it can be helpful to be pushed sometimes in order to learn and grow. But at no time in this learning process should someone be singled out or treated unequally on the basis of any seen or unseen part of their identity.

If you ever have concerns in this course about harassment, discrimination, or any unequal treatment, or if you seek accommodations or resources, I invite you to share directly with me or the TAs. I promise
that we will take your communication seriously and seek mutually acceptable resolutions and accommodations. Reporting will never impact your course grade. You may also share concerns with the applied mathematics department chair (Fadil Santosa, fsantos9@jhu.edu), the Director of Undergraduate Studies (Donniell Fishkind, dfishkil@jhu.edu), the WSE Assistant Dean for Diversity & Inclusion (Darlene Saporu, dsaporu@jhu.edu), KSAS Assistant Dean for Diversity & Inclusion (Araceli Frias, afrias3@jhu.edu) or the Office of Institutional Equity (oie@jhu.edu). In handling reports, people will protect your privacy as much as possible, but faculty and staff are required to officially report information for some cases (e.g., sexual harassment).

**Family Accommodation Policy**

You are welcome to bring a family member to class on occasional days when required (e.g. if emergency child care is unavailable, or for health needs of a relative). In fact, you may see my children in class on days when their school is closed. Please be sensitive to the classroom environment, and if your family member becomes uncomfortably disruptive, you may leave the classroom and return as needed.

**Religious Holidays**

*Religious holidays are valid reasons to be excused from class.* Students who must miss a class or an examination because of a religious holiday must inform the instructor as early in the semester as possible to be excused from class or to make up for any work that is missed. If possible, try to avoid scheduling exams/presentations for major holidays. A list of many religious holidays is maintained [here](https://oie.jhu.edu/religious-accommodations).

More information may be found at the Religious and Spiritual Life website. If you have any questions regarding a particular case or would like any guidance, please do not hesitate to contact the Johns Hopkins University Chaplain at 410-516-1880 or kschnurr@jhu.edu.

Students may also request a religious accommodation through the Office of Institutional Equity at the website: [https://oie.jhu.edu/religious-accommodations](https://oie.jhu.edu/religious-accommodations).

**University Policy on Incompletes**

Important revisions to the Incomplete Grade policy came into effect at JHU in the 2024-2023 academic year. The full policy is available [here](https://oie.jhu.edu/religious-accommodations). The following text is an excerpt:

1. A request for an Incomplete grade must be initiated by the student no later than the last day of classes via the Incomplete Grade Contract available in SIS.

2. The required elements on the Incomplete Grade Contract are listed below; all of these topics should be included in the conversation between the student and the instructor.
   - The reason for the request for an incomplete grade.
   - A description of all outstanding work that must be completed.
   - Date the work is due from the student.
   - The reversion grade if the student does not complete any of the outstanding work.

3. Undergraduate Students: Instructors are required to submit the new grade to the Office of the Homewood Registrar no later than 45 calendar days after the last day of classes. If the Incomplete grade is not resolved within 45 calendar days after the last day of classes, the Incomplete grade is automatically converted to the reversion grade.

4. Graduate Students: If the incomplete grade is not resolved within the agreed period in the incomplete grade contract (which cannot exceed the maximum allowed period of the end of the third week of the next immediate semester), the incomplete grade is automatically converted to the reversion grade.

The significant change here is that there is an Incomplete Grade Contract available to students in SIS to request an incomplete grade. This is how all incomplete grades must be initiated now. The other significant change is the timeline for completion of an incomplete grade, now set at 45 calendar days after the last day.
of classes. Formerly, the default deadline was the end of the third week of the following semester. See the full catalogue entry for considerations for students on academic probation and graduating students.

**Deadlines for Adding, Dropping and Withdrawing from Courses**

Students may add a course up to **February 2, 2024** (independent academic work such as research may be added until **March 3, 2024**). They may drop courses up until **March 3, 2024** provided they remain registered for a minimum of 12 credits. Between **March 4, 2024 and April 12, 2024**, a student may withdraw from a course with a W on their academic record. A record of the course will remain on the academic record with a W appearing in the grade column to indicate that the student registered and then withdrew from the course.

Please see the Registrars website for relevant deadlines for term courses (6-8 weeks, not full semester).

For more information on these and other academic policies, see the following links for undergraduate policies and for graduate policies.