



Syllabus
Applied Mathematics & Statistics 553.793
Turbulence Theory
Spring, 2025
(4 credits, EQ)

Description An advanced introduction to turbulence theory for graduate students in the physical sciences, engineering and mathematics. Both intuitive understanding and exact analysis of the fluid equations will be stressed. Previous familiarity with fluid mechanics is not required, although it could be helpful.

Instructor

Professor Gregory Eyink, eyink@jhu.edu, <http://www.ams.jhu.edu/~eyink>
Office: Wyman Park N449, 410-516-7201, <https://wse.zoom.us/j/7633492271>
Office hours: ??? and by appointment

Teaching Assistant

Lowen Peng, lpeng22@jhu.edu
Office: <https://jhubluejays.zoom.us/j/????>
Office hours: ???

Meetings

Lectures: Tuesday, Thursday, 6:30–7:45pm, Olin 305 and <https://wse.zoom.us/j/98115772652>

Textbook

Recommended:

H. Tennekes & J. L. Lumley, *A First Course in Turbulence* (MIT Press, 1972)
U. Frisch, *Turbulence: The Legacy of A. N. Kolmogorov* (Cambridge University Press, 1995)
The lectures will be based upon the online course notes at:
<https://www.ams.jhu.edu/~eyink/Turbulence/notes.html>

Online Resources

Webpage: Please point your browser to <http://www.ams.jhu.edu/~eyink/Turbulence> 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/spring2025/553793>

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>

Course Topics

- Critical Experiments & Simulations (wind tunnels, wakes, channel flow; Georgia Tech DNS code).
- Navier-Stokes Equation (physical foundations, symmetries, conservation laws).
- Effective “Large-Scale” Equations (derivation & physical interpretation, orders of magnitude).
- Turbulent Energy Cascade (energy flux; Onsager Theorem; scale-locality; helicity cascade).
- Universal Statistics at Small-Scales (scaling, 4/5th law, multifractal model, return to isotropy).
- Vortex Dynamics (cascade & vortex-stretching, Betchov relations, vortex-line motion).
- Lagrangian Particle Dynamics (Taylor & Richardson diffusion, Kraichnan model).
- Wall-Bounded Turbulence (channel-flow, pipe-flow).
- Other Turbulent Systems (two-dimensional & geostrophic, compressible, MHD, etc.)

Course Expectations & Grading

Grading & Homework The student’s final grade will be based upon weekly homework assignments. 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.

Attendance: Students are not formally penalized for missing lectures/sections. However, it is the student’s responsibility 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 not only printouts of results but also all relevant codes. The codes should be sent to the TA or instructor (e.g. in a zipped directory) as specified by them. 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.

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.

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

- 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 (oiie@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.

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://oiie.jhu.edu/religious-accommodations>.

University Policy on Incompletes

Important revisions to the Incomplete Grade policy came into effect at JHU in the 2023-2024 academic year. The full policy is available [here](#). 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. Students are expected to consult with the instructor before submitting the Incomplete Grade Contract. Incomplete grades will be treated as failures when evaluating academic standing. Upon receipt of a student's Incomplete Grade Contract form, the instructor may approve or deny the request, at their discretion.

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 **January 31, 2025** (independent academic work such as research may be added until **March 3, 2025**). They may drop courses up until **February 28, 2025** provided they remain registered for a minimum of 12 credits. Between **March 1, 2025 and April 11, 2025**, 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.