ILLINOIS | Department of Civil and Environmental Engineering

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

College of Engineering
DEPARTMENT OF CIVIL & ENVIRONMENTAL ENGINEERING
CEE 451 – ENVIRONMENTAL FLUID MECHANICS
FALL 2025

Incompressible fluid mechanics with particular emphasis on topics in analysis and applications in civil engineering areas; principles of continuity, momentum and energy, kinematics of flow and stream functions, potential flow, laminar motion, turbulence, and boundary-layer theory.

COURSE INFORMATION:

Course:	**CEE 451 Environmental Fluid Mechanics**
Department:	Civil and Environmental Engineering
Meeting time:	Tuesdays & Thursdays, 03:30-04:50 PM
Meeting location:	2015 Hydrosystems Laboratory
Credits:	3 hours
Prerequisites:	CEE331 or TAM335
Website:	https://canvas.illinois.edu/courses/61902
Instructor:	Hongbo Ma, Ph.D. Assistant Professor Department of Civil and Environmental Engineering University of Illinois at Urbana-Champaign 2018 Hydrosystems Office phone number: TBD Email: hongboma@illinois.edu
Office hours:	TBD
Contact:	Email strongly preferred. Please include CEE451 as the subject in all communications. I'll read emails within 9am-5pm and will do my best to reply within 24h.

Online resources:
If needed due to unexpected circumstances, lectures can be pre-recorded and posted online, or held synchronously online through Zoom. (Please request ahead of the lecture)

Meeting ID: 990 452 6829
Password: 451
Zoom Meeting Link
https://illinois.zoom.us/j/9904526829?pwd=hqBUKGlo4axxbI0QbJSNr80QBbJ19E.1

Recordings: Lectures will be recorded for students registered for the ONLINE section. All recorded videos will be available for ONLINE students through Illinois Media Space.
https://mediaspace.illinois.edu/

1. COURSE DESCRIPTION:
The course introduces the fundamentals of Incompressible fluid mechanics with particular emphasis on topics in analysis and applications in civil engineering areas; principles of continuity, momentum and energy, kinematics of flow and stream functions, potential flow, laminar motion, turbulence, and boundary-layer theory.

2. LEARNING GOALS:
Upon completion of the course the students will identify how to use a single set of equations as the basis to solve a wide-ranging set of fluid problems. Students will learn to use fluid mechanics as a tool to solve problems of environmental significance.

3. COURSE OUTCOMES
The learning objectives listed above contribute to the curriculum outcomes (ABET 1-7) by fostering:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. An ability to communicate effectively with a range of audiences.
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

4. COURSE MECHANICS:
Information will be disseminated primarily via Canvas and through email. Announcements will also be made during lectures. It is the students' responsibility to check announcements in Canvas and their Inbox.

- **Lecture**:
- Two 90 minutes sessions a week. Lecture slides will be posted before each lecture. Required readings, when needed, will be posted online ahead of time and discussed during the lecture. We will also provide a list of additional, suggested readings for those interested in digging deeper.
- *Online lectures*: Asynchronous recordings will be available for all online students through Illinois Mediaspace – in person students can request access if needed. Synchronous zoom meetings at the time of the lecture or prerecorded lectures might be conducted in case of contingencies – I'll do my bet to notify you with as much time in advance as possible.
- **Assignments**: We expect five to six problem sets during the course. Individual submission is the default option. Notice will be given if you are allowed to work in teams to solve the problems. You can submit your reports individually or in teams of up to 3 people if you choose to do so when the teamwork option is given (i.e, only upload one report for a team of up to 3 people). Assignments should be uploaded through Canvas. Specific HW guidelines will be posted in Canvas. A 24-hours, no-questions-asked extension is provided for each assignment. Longer extensions can be discussed for special circumstances.

- **Exams**: One midterm and one final, comprehensive final exam will be assigned. These examinations are designed to assess your understanding of the material. Midterm and final exams will be take-home assignments to work on and submit individually.
- **Attendance and participation**: There will be a series of **non-graded** online quizzes to be filled out after each lecture. This is to make sure everyone is following the material, and to identify if someone is falling behind with attendance or not following the material.

5. LEARNING RESOURCES:

a) Readings

No official textbook is required for the course.

Most of the course will be based on our lecture slides. I'll do my best to post them in advance of each lecture.

Part of the course will be partially based on the books:

- *Fluid Mechanics*, by Pijush K. Kundu, Ira M. Cohen, and David R. Dowling
- *Environmental Fluid Mechanics,* by Rubin, Hillel., and Joseph F. Atkinson.
- *Life in Moving Fluids, by Steven Vogel.*

You **don't have** to buy them. You have access to a digital copy through the University library (please download a copy for your personal use).

Additional required readings and journal manuscripts will be listed on Canvas.

b) Software

Some assignments will require use of computer analysis software.

We strongly encourage you to use either MATLAB, Python, R, computational languages such as Fortran, C, or other Matlab-like, open source alternatives (e.g., Octave or FreeMat). We can't provide assistance on installation or use of the above-mentioned software, but fortunately a) you can find plenty of online tutorials, and b) the person sitting next to you might be an expert on one (or all!) of the above-mentioned programs.

Two suggested readings (**do not need to buy them!**):

- MATLAB Recipes for Earth Sciences, by Martin H. Trauth (available on UIUC library).
- Python Recipes for Earth Sciences, by Martin H. Trauth (available soon on UIUC library).

c) Course material dissemination

Course materials will be posted in Canvas.

Lecture recordings will be available through Illinois Mediaspace (for ONLINE student only).

If needed, large datasets will be posted in Box. If you still haven't activated your Box account, you can register at https://box.illinois.edu/. This will give you unlimited online secure storage.

d) Online Recordings

Lectures will be recorded and made available at: https://mediaspace.illinois.edu/

6. GRADING

Grading will be based on an absolute (**no curved**) scale with the following criteria:

Problem sets	40%
Midterm exam	25%
Final exam	30%
Attendance	5%
Total	**100%**

Letter grades will be assigned as follows:

A	93.0 - 100%	B-	80.0 – 82.9%	D+	67.0 – 69.9%
A-	90.0 - 92.9%	C+	77.0 – 79.9%	D	63.0 – 66.9%
B+	87.0 - 89.9%	C	73.0 – 76.9%	D-	60.0 – 62.9%
B	83.0 – 86.9%	C-	70.0 – 72.9%	F	00.0 – 59.9%

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7. COURSE POLICIES

Sexual Misconduct Reporting Obligation
The University of Illinois is committed to combating sexual misconduct. Faculty and staff members are required to report any instances of sexual misconduct to the University's Title IX Office. In turn, an individual with the Title IX Office will provide information about rights and options, including accommodations, support services, the campus disciplinary process, and law enforcement options.

A list of the designated University employees who, as counselors, confidential advisors, and medical professionals, do not have this reporting responsibility and can maintain confidentiality, can be found here:

wecare.illinois.edu/resources/students/#confidential

Other information about resources and reporting is available here:

wecare.illinois.edu

Academic Integrity
The University of Illinois at Urbana-Champaign Student Code should also be considered as a part of this syllabus. Students should pay particular attention to Article 1, Part 4: Academic Integrity. Read the Code at the following URL:

http://studentcode.illinois.edu/

Academic dishonesty may result in a failing grade. Every student is expected to review and abide by the Academic Integrity Policy:

https://studentcode.illinois.edu/article1/part4/1-401/.

Ignorance is not an excuse for any academic dishonesty. It is your responsibility to read this policy to avoid any misunderstanding. Do not hesitate to ask the instructor(s) if you are ever in doubt about what constitutes plagiarism, cheating, or any other breach of academic integrity.

Religious Observances
Illinois law requires the University to reasonably accommodate its students' religious beliefs, observances, and practices in regard to admissions, class attendance, and the scheduling of examinations and work requirements. You should examine this syllabus at the beginning of the semester for potential conflicts between course deadlines and any of your religious observances. If a conflict exists, you should notify your instructor of the conflict and follow the procedure at:

https://odos.illinois.edu/community-of-care/resources/students/religious-observances/
to request appropriate accommodations. This should be done in the first two weeks of classes.

Disability-Related Accommodations
To obtain disability-related academic adjustments and/or auxiliary aids, students with disabilities must contact the course instructor and the Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES, you may visit 1207 S. Oak St., Champaign, call 333-4603, e-mail disability@illinois.edu or go to https://www.disability.illinois.edu/. If you are concerned you have a disability-related condition that is impacting your academic progress, there are academic screening appointments available that can help diagnosis a previously undiagnosed disability. You may access these by visiting the DRES website and selecting "Request an Academic Screening" at the bottom of the page.

Family Educational Rights and Privacy Act (FERPA)
Any student who has suppressed their directory information pursuant to Family Educational Rights and Privacy Act (FERPA) should self-identify to the instructor to ensure protection of the privacy of their attendance in this course. See https://registrar.illinois.edu/academic-records/ferpa/ or more information on FERPA.

Emergency Response Recommendations
Emergency response recommendations can be found at the following website: https://police.illinois.edu/services/campus-safety-tips/. I encourage you to review this website and the campus building floor plans website within the first 10 days of class. http://police.illinois.edu/emergency-preparedness/building-emergency-action-plans/.

Anti-Racism and Inclusivity Statement
The Grainger College of Engineering is committed to the creation of an anti-racist, inclusive community that welcomes diversity along a number of dimensions, including, but not limited to, race, ethnicity and national origins, gender and gender identity, sexuality, disability status, class, age, or religious beliefs. The College recognizes that we are learning together in the midst of the Black Lives Matter movement, that Black, Hispanic, and Indigenous voices and contributions have largely either been excluded from, or not recognized in, science and engineering, and that both overt racism and micro-aggressions threaten the well-being of our students and our university community.

The effectiveness of this course is dependent upon each of us to create a safe and encouraging learning environment that allows for the open exchange of ideas while also ensuring equitable opportunities and respect for all of us. Everyone is expected to help establish and maintain an environment where students, staff, and faculty can contribute without fear of personal ridicule, or intolerant or offensive language. If you witness or experience racism, discrimination, micro-aggressions, or other offensive behavior, you are encouraged to bring this to the attention of the course director if you feel comfortable. You can also report these behaviors to the Bias Assessment and Response Team (BART) [https://diversity.illinois.edu/report-an-incident/]. Based on your report, BART members will follow up and reach out to students to make sure they have

the support they need to be healthy and safe. If the reported behavior also violates university policy, staff in the Office for Student Conflict Resolution may respond as well and will take appropriate action.

Support Resources and Supporting Fellow Students in Distress

As members of the Illinois community, we each have a responsibility to express care and concern for one another. If you come across a classmate whose behavior concerns you, whether in regards to their well-being or yours, we encourage you to refer this behavior to the Student Assistance Center (1-217-333-0050) or online at

odos.illinois.edu/community-of-care/referral/

Based upon your report, staff in the Student Assistance Center reaches out to students to make sure they have the support they need to be healthy and safe. Further, as a Community of Care, we want to support you in your overall wellness. We know that students sometimes face challenges that can impact academic performance (examples include mental health concerns, food insecurity, homelessness, personal emergencies). Should you find that you are managing such a challenge and that it is interfering with your coursework, you are encouraged to contact the Student Assistance Center (SAC) in the Office of the Dean of Students for support and referrals to campus and/or community resources. The SAC has a Dean on Duty available to see students who walk in, call, or email the office during business hours. For mental health emergencies, you can call 911 or contact the Counseling Center

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Important dates

Please check the calendar at:

https://senate.illinois.edu/a_calendar.asp

for deadlines to add and drop courses, as well as elect and change credit/no credit options.

8. COURSE CONTENT

Below are tentative topics and expected dates. This is a dynamic syllabus, so they are subject to change based on progress or unexpected contingencies.

Lecture	Date	Topic
1	08/26	Introduction
2	08/28	Scalars, vectors and tensors
3	09/02	Divergence theorem, pressure, Archimedes' principle
4	09/04	Convective flux, fluid mass conservation
5	09/09	Diffusive flux, heat and contaminant conservation
6	09/11	Momentum conservation: Cauchy equation
7	09/16	Momentum conservation: Cauchy equation
8	09/18	Symmetry of the stress tensor
9	09/23	Constitutive relation for Newtonian fluid
10	09/25	The strain rate tensor and isotropy
11	09/30	Rotation rate tensor and vorticity
12	10/02	Laminar plane Couette and open channel flow
13	10/07	Euler equations of inviscid flow
14	10/09	Euler equations of inviscid flow
15	10/14	Potential flow and the Bernoulli equation
16	10/16	2D potential flows
17	10/21	Simple examples of 2D potential flows
18	10/23	More examples of 2D potential flows
19	10/28	Flow around a cylinder
20	10/30	Boundary Layer
21	11/04	Solution for the boundary layer on a flat plate
22	11/06	Turbulence
23	11/11	Turbulence
24	11/13	Surface water waves
25	11/18	Surface water waves
26	11/20	Fall Break
27	11/25	Fall Break
28	11/27	Geophysical fluid motions
29	12/02	Geophysical fluid motions
30	12/04	Introduction to biofluid mechanics
31	12/09	Recap
32	12/11	Reading Day
	12/12-12/18	Finals

Run > Hide > Fight

Emergencies can happen anywhere and at any time. It is important that we take a minute to prepare for a situation in which our safety or even our lives could depend on our ability to react quickly. When we're faced with almost any kind of emergency – like severe weather or if someone is trying to hurt you – we have three options: Run, hide or fight.

Run

Leaving the area quickly is the best option if it is safe to do so.

- Take time now to learn the different ways to leave your building.
- Leave personal items behind.
- Assist those who need help, but consider whether doing so puts yourself at risk.
- Alert authorities of the emergency when it is safe to do so.

Hide

When you can't or don't want to run, take shelter indoors.

- Take time now to learn different ways to seek shelter in your building.
- If severe weather is imminent, go to the nearest indoor storm refuge area.
- If someone is trying to hurt you and you can't evacuate, get to a place where you can't be seen, lock or barricade your area if possible, silence your phone, don't make any noise and don't come out until you receive an Illini-Alert indicating it is safe to do so.

Fight

As a last resort, you may need to fight to increase your chances of survival.

- Think about what kind of common items are in your area which you can use to defend yourself.
- Team up with others to fight if the situation allows.
- Mentally prepare yourself – you may be in a fight for your life.

Please be aware of people with disabilities who may need additional assistance in emergency situations.

Other resources

- **police.illinois.edu/safe** for more information on how to prepare for emergencies, including how to run, hide or fight and building floor plans that can show you safe areas.
- **emergency.illinois.edu** to sign up for Illini-Alert text messages.
- **Follow the University of Illinois Police Department** on Twitter and Facebook to get regular updates about campus safety.