# ME 310: Fundamentals of Fluid Dynamics
# Fall 2023 (Sections AL3, 3ZJ)

**Instructor:** **Prof. Randy H. Ewoldt**
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**Lab Manager:** **Prof. Blake Johnson**
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**Course Websites**: via Canvas.
Ewoldt Lecture: https://canvas.illinois.edu/courses/39856
Lab: will appear when you login to Canvas

**Lectures:** MWF 2–2:50 pm, 1306 Everitt Laboratory
In-person attendance is required.
Join iClicker: https://join.iclicker.com/OXOJ

**Laboratory Sections:** Required lab class each week (**starts second week, Aug 28, 2023**)
In person in 126 Talbot. Timing based on your lab section.

**Discussion Forum and Course Q&A:**
We will use Piazza as a discussion forum and for interaction. All questions should be posted to Piazza (not email). Email should only be used for private communications, and still the Course TA should be CC'd on the email.
For Piazza, find our class page at: https://piazza.com/illinois/fall2023/me310. The goal of this is to provide a location for connection and community. There, you can ask questions about lecture, homework, lab, etc., and use it as a way to meet and interact with other students (if interacting with others is of interest). The platform will let you benefit from the collective knowledge of your classmates and instructors.

## COURSE DESCRIPTION

Fluids: forces and motion. Students will learn how to understand, predict, and design for scenarios involving fluids. Three truths are fundamental to the physics: conservation of momentum, mass, and energy. Beyond fluids, students will strengthen their general understanding of forces and motion, sharpen their mathematical skills, improve their experimental data collection and analysis, and learn how to use dimensional analysis to dramatically simplify complex parameter spaces.

From the Course Catalog:
Fundamentals of fluid mechanics with coverage of theory and applications of incompressible viscous and inviscid flows, and compressible high speed flows. Credit is not given for both ME 310 and either TAM 335 or CEE 331. Prerequisite: MATH 285 OR MATH 286 OR MATH 441; credit or concurrent registration in ME 200.

## COURSE CONTENT OUTLINE

- Introduction (Fluids: properties; definitions; analysis methodology)
- Fluid Statics (Fluids that don't flow: hydrostatics; buoyancy; manometry; stability)
- Fluid Kinematics (How fluids flow: streamlines, etc.)
- Integral Conservation Equations (Why fluids flow: mass, momentum and energy)
    - Control volume analysis ("chunks" of fluid)
    - Differential analysis ("points" of fluid)
- Dimensional Analysis and Similarity
  (Making it easier: nature cares not about meters and seconds!)
- Internal Flow (Application: channel and pipe flows; head loss)
- External Flow (Application: boundary layers; momentum integral analysis; lift and drag)
- Compressible Flow (Application: one-dimensional gas dynamics)

## PREREQUISITES

Prior credit in MATH 285 or MATH 286 and prior credit or concurrent registration in ME 200 are required. The importance of some degree of dexterity with calculus cannot be overstated. In this context, the material of MATH 241 Calculus III is even more important. If differential equations as well as symbols like $\partial$ and $\nabla$ do not "ring a bell", attendance of this course will, sooner or later, become problematic.

## REQUIRED TEXT

Munson, Young and Okiishi's Fundamentals of Fluid Mechanics, 9th Edition, Wiley (2021)

## GRADING

| | |
|---|---|
| Laboratory | 25% |
| Homework | 20% |
| Lecture Participation | 5% |
| Exam I | 15% (Wednesday, Sep. 27, 7:00-8:15PM, Location TBD) |
| Exam II | 15% (Wednesday, Nov 8, 7:00-8:15PM, Location TBD) |
| Final Exam | 20% (During Finals Week, specific Time/Date/Location TBD) |

Your final letter grade will be assigned using the following numerical cutoffs
(which may be lowered but will not be raised):

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 96–100 | A+ | 86–89 | B+ | 76–79 | C+ | 66–69 | D+ | 0–59 | F |
| 92–96 | A | 82–86 | B | 72–76 | C | 62–66 | D | | |
| 89–92 | A- | 79–82 | B- | 69–72 | C- | 59–62 | D- | | |

## LABORATORY

This course has a separate laboratory section that will help illustrate the concepts presented in class through physical demonstration.

Detailed information for the laboratory is available at the laboratory Canvas website.

While you will perform the lab activities as a group, each student must prepare his/her own written report. **Plagiarism of lab reports is a serious ethical violation and will be dealt with using the most stringent available counter-measures.** TAs will be regularly checking for plagiarized reports using an extensive database of reports from previous semesters and other institutions.

## HOMEWORK

Homework is an important element of the course. Problem sets will be assigned approximately weekly and submitted via Canvas as PDF. Late homework will not be accepted without prior arrangement and a good reason (as outlined in UIUC rules).

IMPORTANT: Use words to explain your thought process! Not just equations. A fellow engineer should be able to easily follow your reasoning. Neatness, clarity, and "professionalism" of presentation will affect credit to a significant extent. Your solutions must be neatly arranged. We suggest using the structure of subsections for "Given", "Find", "Solution", and "Comments". This will help ensure that you include a description of the problem to be solved, a diagram (if appropriate) showing important features of the problem (coordinate system, control volumes, relevant lengths, forces, etc.) and step-by-step analysis with the final result clearly identified (e.g. boxed).

Homework solutions will be posted on the course website after the due date. At the end of the semester, your lowest homework-assignment grade will not be included in the calculation of your final grade.

Your chances of doing well in this course are minimal if you do not independently do the assigned problems, and understand them deeply to repair weaknesses and develop new insights. We are ready to

help you in every way to master the course material. There is, however, a profound difference between being taught and learning.

## LECTURE PARTICIPATION

Regular attendance at lectures is required.

iClickers will be used to document attendance and participation.

(a) Expect iClicker questions in every lecture. Each lecture will receive an overall score for your participation.

(b) Your five lowest scores will be dropped. These drops should be reserved for unexpected occurrences such as sickness or family emergency.

## EXAMS

Three (3) examinations will be given, including a final exam that includes comprehensive material. These exams are meant to assess your understanding of the basic, fundamental concepts presented in class and illustrated in the homework problems and lecture examples.

Exam I and Exam II will be given **in the evening, on Wednesday Sep. 27** and **Wednesday Nov. 8**. The Final Exam will be in person during the 3-hour assigned time by the Registrar.

The format for the exams will be closed book, but one self-prepared two-sided 8.5”x11” equation sheet will be allowed. The final exam will be of the same format as the mid-semester exams but will be comprehensive in nature.

## GRADING POLICIES

Your submissions must represent your own understanding. You are encouraged to attempt homework problems individually at first, followed by discussion with your peers, but do not duplicate anyone’s work. Any duplication identified during the grading process will result in zero credit and potential further action as allowed by UIUC rules. Partial credit may be given on both homework and examinations as long as a coherent thought process is noted in your solution. Writing down the correct answer without justification will receive zero credit.

## ACADEMIC INTEGRITY

Infractions will not be tolerated; they will be dealt with using the most stringent available counter-measures. See the University’s Student Code, Article 1, Part 4
https://studentcode.illinois.edu/article1/part4/1-401/

## ADDITIONAL INFORMATION FOR THE UNIVERSITY OF ILLINOIS AND THE GRAINGER COLLEGE OF ENGINEERING

### 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 if you are ever in doubt about what constitutes plagiarism, cheating, or any other breach of academic integrity.

### 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.

### 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.

### 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/ for more information on FERPA.

### 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.

**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://bart.illinois.edu/). 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.