

ME 509 INTERMEDIATE FLUID MECHANICS (3 credits)

Instructor:

Dr. Whitney Yu
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Grader: TBA

Class Hours:

Monday and Wednesday: 6:00 - 7:15 pm
SL137

Office Hours:

Instructor: Monday and Wednesday: 4:45 - 5:45 pm
SL 260H (Classroom teaching days) or Zoom upon request
Grader: Tuesday and Thursday: 1-2 pm
IO201

Textbook:

Panton, R. L., Incompressible Flow, 4th Edition, J. Wiley

1. Recommended reference books:

- F. M. White, Viscous Fluid Flow, Third Edition, McGraw-Hill, New York, 2006
- P.K. Kundu and I.M Cohen, Fluid Mechanics, 4th Edition, Burlington: Academic Press. 2007. (Full text available on IUPUI Library)
- G.K. Batchelor, An Introduction to Fluid Mechanics, Cambridge University Press (1967)

2. Recommended link: <http://www.efluids.com>

<https://www.youtube.com/user/fyfluidynamics>

3. Useful fun stuff:

- *An Album of Fluid Motion* by Milton van Dyke, Parabolic Press.
- *Multi-Media Fluid Mechanics* (CD-ROM), by G. M. Homsy et al., Cambridge University Press.

4. Academic interest Journals: *Physics of Fluids*, *Journal of Fluid Mechanics*, *Annual Review of Fluid Mechanics*, *Journal of Turbulence*

Prerequisite (*Electronic Quiz on Canvas*):

ME 31002 Fluid Mechanics or equivalent.

Description:

This course covers principal concepts, basic laws, and governing equations of fluid dynamics focusing on Newtonian fluids and viscous flows. Topics include (but are not limited to) kinematics of local fluid motions, conservation laws and Navier-Stokes equations, dimensional analysis, compressible flows, incompressible flows, boundary layer, etc.

Course outcomes:

Upon completion of the course, students are expected to be able to do the followings

- Understand kinematics and fluid dynamics on an intermediate level
- Derive governing equations based on conservation laws
- Solve various Newtonian viscous systems with respect to incompressible and compressible flows
- Perform dimensional analysis
- Derive boundary layer equations with respect to specific flows

Grading:

Course grade scale will follow the Letter Grades with +/- on Canvas as

Name:	Range:	
A+	100%	to 97.0%
A	< 97.0%	to 93.0%
A-	< 93.0%	to 90.0%
B+	< 90.0%	to 87.0%
B	< 87.0%	to 83.0%
B-	< 83.0%	to 80.0%
C+	< 80.0%	to 77.0%
C	< 77.0%	to 73.0%
C-	< 73.0%	to 70.0%
D+	< 70.0%	to 67.0%
D	< 67.0%	to 63.0%
D-	< 63.0%	to 60.0%
F	< 60.0%	to 0.0%

The instructor may or may not provide opportunities for students to earn extra credits based on the entire class performance. Grade upgrade requests based on personal expectation/imagination or special needs will not be issued.

<i>Final exam</i>	25%
<i>In-class exam</i>	25%
<i>Homework</i>	30%
<i>Project</i>	20%

- Exams will be held in the classroom. Exam problems are similar to the HW problems and classroom examples. The exam format will be announced one week before the exam.
- HW problems are mainly from the textbook. Students are expected to demonstrate the technical capability to solve problems. The HW solutions should be correct and the presentations of the solutions should be logical, complete, and understandable. HWs are submitted and graded on Canvas. Students are responsible for **high-quality electronic copies**. If the HW is returned because of the bad quality, the student is responsible for re-scanning and uploading within 24 hours after the notice and the penalty will

be 10% of the HW points. **Late HW** will cause a penalty of 10% of the HW points off per late day. **Once the HW is graded, no late HW is accepted.**

- The project will be assigned in week 8.
- There will be **NO MAKEUP** exams. On the rare occasion that a student is excused with **valid written documents for emergency** (e.g. doctor notes or medicine purchase receipts for illness, evidence or witness for vehicle failure, etc.) or a **prior written request and approval for non-emergency**, the missed points can be credited. The instructor reserves the right to decide how to credit based on specific cases.

Homework Format:

It is strongly recommended that each problem is solved including the following components:

Known: A brief summary of the problem, “in your own words”.

Find: Quantities to be determined.

Sketch: Properly labeled and indicated- physical system and property diagrams

Assumptions: Modeling assumptions that are used in solving the problem are listed and clearly indicated as a constraint.

Properties: Substance identified and needed properties, value (units), and source.

Analysis: The problem is solved in a systematic and logical manner, showing all steps, starting from the fundamental equation(s) from which the analysis begins [and numerical values (with units) are shown]. The final results are clearly indicated.

Discussion: Any comments relative to the results.

Canvas:

The entire course-related communication outside of lectures and office hours is through <http://canvas.iu.edu> FA22-IN-ME-50900. It is noted that

- All the information and materials will be accessed on this system throughout the semester including messages and announcements, syllabus and course schedule, supplementary handouts, HW and project assignments, grades, and so on.
- Students are required to send **course-related messages through Canvas/Inbox.**
- Students are responsible to set up notifications on Canvas and check their emails as well as the course website on Canvas time accordingly for any course information.
- Students are encouraged to discuss course issues on Canvas/Discussion.

~~~~~ **IMPORTANT NOTES** ~~~~~

- Extenuating circumstances may result in changes to the assignments or schedule. Please setup **instant Canvas notifications** for any changes, announcements, emails, etc.
- Everyone deserves to be treated with **dignity and respect**. Within this classroom, civility requires mutual respect for all class members and instructor(s) and their knowledge and expertise. All members of this class (instructor and students) are responsible for and expected to promote respectful and courteous language, demeanor, and actions. Behavior that is offensive, disruptive, intimidating, dismissive, or condescending will not be tolerated from either the instructor or the student. Students are required to attend every class in the classroom. A sign sheet will be provided for each classroom lecturing. A written excuse is expected before the class for nonemergency or after the class for an emergency.
- Currently, masks are *optional* on the IUPUI campus. Note that campus guidance on mask-wearing and other health safety protocols may be relaxed or strengthened during the semester in response to updated CDC guidance, changing caseloads, or other factors. The most up-to-date information on current **COVID-19 policies** in the IU system, including a FAQ and information about drop-off testing, is available at <https://www.iu.edu/covid/>.
- Students are aware of the statements made regarding cheating in the IUPUI “Student Rights and Responsibilities” booklet. **Academic misconducts** will be handled according to the guidelines in that booklet. Penalties for such misconduct include lowering of a student’s grade as well as dismissal from school. A quote from the above-mentioned booklet is worthwhile. “It is the responsibility of the student not only to abstain from cheating but, in addition, to guard against making it possible for others to cheat. Any student who helps another student to cheat is as guilty of cheating as the student he/she assists.” The website for the student code of conduct is <https://studentcode.iu.edu/rights/index.html>
- Accommodations are available for students with special challenges or disabilities that may affect their performance in this class. To determine if you are eligible for accommodations, you must register with **Adaptive Educational Services (AES)**, which can be reached at (317) 274-2050. You must provide your instructor with the documentation from AES showing you have registered with the service. For more information, visit the AES website at <https://diversity.iupui.edu/offices/aes>
- During the semester, if you find that life stressors are interfering with your academic or personal success, consider contacting IUPUI's **Counseling and Psychological Services (CAPS)**. All IUPUI students are eligible for individual counseling services at minimal fees. Group counseling services are free of charge. CAPS also performs evaluations for learning disorders and ADHD; fees are charged for testing. CAPS is located in Walker Plaza, Room 220 (719 Indiana Avenue) and can be contacted by phone (317-274-2548). For more information, see the CAPS website at

<https://studentaffairs.iupui.edu/health/counseling-psychological/index.html>. For additional information about general health services, see the Student Health and Wellness website at <http://studentaffairs.iupui.edu/health-wellness/counseling-psychology/index.shtml>.

- What you should know about **sexual misconduct**: IUPUI does not tolerate acts of sexual misconduct, including sexual harassment and all forms of sexual violence. If you have experienced sexual misconduct, or know someone who has, the University can help. It is important to know that federal regulations and University policy require faculty to promptly report complaints of potential sexual misconduct known to them to their campus Deputy Title IX Coordinator(s) to ensure that appropriate measures are taken and resources are made available. The University will work with you to protect your privacy by sharing information with only those that need to know to ensure the University can respond and assist. If you experience or witness any act of sexual misconduct, go to <http://stopsexualviolence.iu.edu/help/iupui/index.html>. If you are seeking help and would like to speak to someone confidentially, you can make an appointment with a Mental Health Counselor on campus (contact information available at [https://stopsexualviolence.iu.edu/help/confidential\\_resources.html](https://stopsexualviolence.iu.edu/help/confidential_resources.html)).

### Course Schedule

The schedule is tentative. It is subjected to modify or change with or without prior notice.

| <b>Week</b> | <b>Topic</b>                               | <b>Assignment due</b> |
|-------------|--------------------------------------------|-----------------------|
| 1           | Introduction                               |                       |
|             | Math review (Ch3)                          |                       |
| 2           | Kinematics (Ch 1)                          |                       |
|             | Local motion (Ch4)                         | HW1 (Ch 1 and 3)      |
| 3           | Labor Day (No class)                       |                       |
|             | Continuity equation (Ch 5)                 | HW2 (Ch 4)            |
| 4           | Momentum equations (Ch 5)                  |                       |
|             | Recitation (HW 1 and 2)                    |                       |
| 5           | Energy equations (Ch 5)                    |                       |
|             | Newtonian fluids and N-S equations (Ch 6)  | HW3 (Ch 5)            |
| 6           | PI theorem and its application (Ch 8)      |                       |
|             | Dynamic similarity and scaling laws (Ch 8) |                       |
| 7           | Project assignment                         | HW4 (Ch 6 and 8)      |
|             | Compressible flow (Ch 9)                   |                       |
| 8           | Recitation (HW 3 and 4)                    | MS1                   |
|             | Mid-term review                            |                       |
| 9           | Fall break (No class)                      |                       |
|             | Mid-term exam                              |                       |
| 10          | Incompressible flow (10)                   | HW5 (Ch 9)            |
|             | Incompressible flow patterns -1(Ch 7)      |                       |
| 11          | Incompressible flow patterns -2 (Ch 7)     |                       |
|             | Some solutions of NS equations -1 (Ch 11)  | HW 6 (Ch 10 and 7)    |
| 12          | Recitation (HW5 and 6)                     |                       |
|             | Some solutions of NS equations -2 (Ch 11)  |                       |
| 13          | Boundary layer – 1 (Ch 20)                 | MS 2                  |
|             | Boundary layer – 2 (Ch 20)                 |                       |
| 14          | Project time (no class)                    | HW7 (Ch 11 and 20)    |

|    |                               |                    |
|----|-------------------------------|--------------------|
|    | Thanksgiving break (no class) |                    |
| 15 | Research presentation         |                    |
|    | Recitation (HW7)              |                    |
| 16 | Final review                  |                    |
|    | Project wrap-up (no class)    | MS3                |
| 17 | Oral presentation             | Project report due |
|    | <b>Final exam</b>             |                    |

\* The DUE dates are just for a guideline. If there is a conflict with the Canvas assignment, please follow the assignment.