MANE 4070 Aerodynamics I
4 Credits, Fall 2022, M/Th 12:00-13:50, PITTS 4114

Instructors: Prof. Shaowu Pan. Office: JEC 2032. Email: `pans2@rpi.edu`.
Office hours: Monday 14:00-16:00 in my office or you can meet me over Webex: `https://rensselaer.webex.com/meet/pans2`.

TA: Anubhav Halder, Office hours: Wednesday 14:00-16:00. Email: `haldea@rpi.edu`.
Webex: `https://rensselaer.webex.com/meet/haldea`.

Course Description: An introduction of applied fluid mechanics for undergraduates. It covers basic airplanes/flight mechanics concepts, standard atmosphere model; inviscid and irrotational flow: incompressible potential flow theory; thin airfoil theory; finite wing theory; compressible flow and shock waves; rocket-nozzle theory; subsonic compressible flow over airfoils: linear theory; linearized supersonic flow; effects of viscosity: boundary layer theory applied to airfoils, flow separation and stall.

Course Goals: I will introduce to you the basic concepts and methods for modeling objects moving through any fluid (gas or liquid), which can be summarized in the following theories:

- Basics of kinematics and dynamics of fluid flow
- Incompressible potential flow theory: "How do mathematicians tackle fluid flows?"
- Thin airfoil theory: "How do aerodynamics engineers tackle 2D fluid flows?"
- Finite wing theory: "How about 3D effects?"
- Transonic/Supersonic flows: "Thermodynamics joins the game."
- Viscous flow theory: "The equations that control (nearly) all fluid motions."
- Boundary layer theory: "How physical intuition helps in simplifying the problem."

Textbook: *Fundamentals of Aerodynamics*, sixth edition, by John D. Anderson, McGraw Hill. 4th and 5th are also fine.

Format:

1. Lectures are all given in person. There will be a 10 mins break every 50 mins.
2. The TA will be recording a recitation each week to help with the understanding of the material, including examples, guidance for the homework, and preparations for exams.
3. Homework is to be submitted via LMS. You may want to scan your homework.
4. On HW and Exams detailed work supporting answers must be shown.

Grading:

- HW: 20%
- 3 Midterm Exams: 60%
- Comprehensive Final Exam: 20%

Pre-requisites:

- ENGR 2250 (Thermal and Fluids Engineering I)
- MANE 2060 (Fundamentals of Flight)

You should know calculus, complex numbers, differential equations, basic knowledge of thermodynamics and incompressible flows.

Policy:

- Allowable collaboration for homework is restricted to discussion of relevant concepts.
- An assignment or project will receive a 10% penalty if handed in within 24 hours of the deadline; a 25% penalty if handed in within a week of the deadline, and; a 100% penalty otherwise. In other words, assignments and projects handed in a week past the deadline will receive a grade of 0, notwithstanding excused absences.
- All homeworks are due on a specific day in class, unless an exception is discussed earlier.
- One of the total four exams can be waived, which means the rest 3 exams will share the 80% portion of total scores.
- In general, there will be no scheduled retests or make-up exams. A comprehensive exam will be administered the day after the final for anyone who missed any of the exams for an excused absence, requiring an official note from the Student Health Service, Dean of Students Office, Associate Dean of Engineering for Academic and Student Affairs, or RPI Athletic Department (Varsity Sports only).

Academic Integrity: Student-teacher relationships are built on trust. Students must trust that teachers have made appropriate decisions about the structure and content of the courses they teach. Teachers must trust that the assignments which students turn-in are their own. Acts which violate this trust undermine the educational process. The Rensselaer Handbook defines various forms of Academic Dishonesty and procedures for responding to them. All forms are violations of the trust between students and teachers. Students should familiarize themselves with this portion of the Handbook and should note that the penalties for plagiarism and other forms of cheating can be quite harsh. While collaborative or group work will be encouraged in many instances, there will also be times when individual work is required, such as during the tests and the final exam. While collaboration may be helpful when thinking about a particular homework or computer assignment, check with the instructor or the TA about when an assignment is meant to be collaborative vs. individual.

Schedule:

Date	No.	Content	Section	HW Due
M 08/29	1	Introduction	1.1-1.12	
Th 09/01	2	Kinematics	2.1-2.13	
T 09/06	3	Kinematics	2.14-2.18	
Th 09/08	4	Dynamics	3.1-3.6	HW 1
M 09/12	5	Dynamics	3.7-3.10	
Th 09/15	6	Potential Flow	3.11-3.14	HW 2
M 09/19	7	Potential Flow	3.15-3.21	
Th 09/22	8	Airfoil Theory	4.1-4.6	HW 3
M 09/26	9	Airfoil Theory	4.7-4.15	
Th 09/29		**Mid-term 1** (Before airfoil theory)		HW 4
M 10/03	10	Finite Wing Theory	5.1-5.3	
Th 10/06	11	Finite Wing Theory	5.4-5.9	HW 5
M 10/10 (Columbus)				
Th 10/13	12	Compressible Flow	7	HW 6
M 10/17	13	Compressible Flow	8	
Th 10/20	14	Compressible Flow	9.1-9.5	HW 7
M 10/24	15	Compressible Flow	9.6-9.11	
Th 10/27	16	Compressible Flow	10.1-10.2	HW 8
M 10/31	17	Compressible Flow	10.3-10.4	
Th 11/03	18	Compressible Flow	10.5-10.7	HW 9
M 11/07	19	Linearized Theory	11	
Th 11/10	20	Linearized Theory	12	HW 10
M 11/14	21	Viscous Flow	12	
Th 11/17	22	Viscous Flow	15	HW 11
M 11/21		**Mid-term 2** (Before 10.2)	18.1-18.5	
Th 11/24 (Thanksgiving)				
M 11/28	23	Intro Boundary Layers	16.1-16.3	
Th 12/01	24	Laminar Boundary Layers	18.1-18.5	HW 12
M 12/05	25	Turbulent Boundary Layers	19	
Th 12/08		**Mid-term 3**		HW 13
12/14-20		**Comprehensive Final Exam**		