Last Revised, January 5, 2024

General Information for AAE 520
Experimental Aerodynamics
Prof. Joseph Jewell, Spring 2024

Catalog Description of Course:
AAE 520, Experimental Aerodynamics, Class 2, lab 2, 3 credits. Prerequisite: AAE 334 or equivalent.

Theory and application of experimental techniques and instrumentation for aerodynamics and fluid mechanics. Computer data acquisition, wind tunnels, force balances, flow visualization, pressure probes, hot-wire anemometry, laser Doppler velocimetry, and turbulence measurements.

Notes:
Enrollment is normally limited to 20 students. If there are more than 20 students enrolled, the following schedule may need to be modified in order to accomodate the students on the available apparatus. Since there is only one set of apparatus for each preplanned lab, and groups of more than two are not desirable, it is difficult to schedule the apparatus for more than 10 lab groups (40 hours per week).

This class in its present format was organized by Prof. John Sullivan. Spring 2020 was the last time this course was taught by Prof. Steve Schneider. Prof. Jewell took over this course, beginning in Spring 2021.

Class Hours: Lecture MW 4:30-5:20PM, NISW 184. Lab, arrange hours. First week, 2 hours lecture and no lab, while the lab schedule is being worked out. Following 6 weeks, 1 hour lecture and 4 hours lab per week (including an off day for the MLK holiday, which may require flexibility in arranging an alternate time). The other hour of weekly class time will be used for oral presentations and discussions, with students attending on alternate weeks. During the final project, there will be no lectures, with both weekly hours scheduled for weekly oral presentations by the project groups. The computer-generated lab times provided by the registrar are used only as a first trial towards developing the lab schedule. Groups of two (to the extent possible, not three!) need to be arranged during the week. There is only one set of apparatus for each lab.

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Seldom at Armstrong, more often at ASL, sometimes at HARF, sometimes remote, *often* on travel.
Email, call, or visit lab.

T.A.: Bethany Price, `price163@purdue.edu`, AERO Room 17
T.A.: Samantha Miller, `mill1904@purdue.edu`, AERO Room 17
T.A.: Trey Francis, `franci74@purdue.edu`, AERO Room 17
T.A. Emeritus: A. Carson Lay, `lay7@purdue.edu`, AERO Room 4

While any of the TAs are available to help, Bethany and Trey will be the primary for Lab 1, Bethany will have primary responsibility for Lab 2, and Samantha will be primary for Lab 3.

Grading: 3 preplanned labs, 50% total. Project, 50%. In the event of a major campus emergency, such as a resurgence of COVID-19, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances. Any necessary changes are to be communicated via email.

Recommended References: There is no textbook. However, students will be expected to study reference materials in order to understand the use and operation of the experimental apparatus. The following are listed as recommended references for the course, and should thus be available in the bookstores. If you plan to keep working in the area it would be worth purchasing them, as opposed to borrowing them. The first two texts are also on reserve in the Engineering Library.

1. *Low-Speed Wind Tunnel Testing*, J.B. Barlow, W.H. Rae, Jr., and Alan Pope, Third Edition, Wiley, New York, 1999. Contains a lot of standard information on low-speed wind tunnels and also some information about instrumentation.

2. *Fluid Mechanics Measurements*, edited by Richard Goldstein, Jr. Various editions are available. Latest is published by Taylor and Francis, 1996. Used copies may also be available, my own copy is published by Hemisphere in 1983. Best known single reference for common instrumentation.

3. *Writing Styles and Standards in Undergraduate Reports*, 2nd edition, by Sheldon Jeter and Jeffrey Donnell, College Publishing, 2011. One of many books on writing reports. You might prefer *A Scientific Approach to Writing for Engineers and Scientists*, by Robert Berger, Wiley and IEEE Press, 2014.

Outline:

The 3 preplanned labs are designed as a bridge between fully pre-organized labs such as those in 333L and 334L and the open-ended project that concludes the course. In the 3 pre-planned labs, critical questions have been posed, a variety of apparatus is already designed and tested, and some experimental procedures are available. However, there will be many different ways in which to use the lab apparatus, each group may address somewhat different questions, and the groups may be required to do some adjusting and aligning to make the apparatus work. This makes room for the creative process, and for learning by studying references and practicing with the equipment, which are important parts of more advanced experimental work. Two successive four-hour sessions are scheduled for each lab, to give time for this process, as well as time between use of the apparatus for reducing and studying preliminary data, discovering problems, studying reference materials, and getting advice from the instructors. Students can also gain necessary experience in developing and troubleshooting lab apparatus. Detailed cookbook procedures will not be handed out. The results are to be reported in both written and oral form.

1. Warmup lectures, week 1, orientation, lab tour, introduction to oscilloscopes, and scheduling.

2. Lab 1 (Weeks of 15 and 22 Jan.): **Turbulence and Wakes.** Calibrate hot wire in wake tunnel. Place wire in cylinder wake, study signal acquisition effects such as aliasing. Sample data, compute power spectra of turbulence under different conditions. Measure profiles of mean velocity and fluctuations at different downstream locations, for a cylinder and an airfoil. Airfoil may be placed at small angle of attack. Integrate wake profiles to get drag, look at effect of downstream distance on the result. Compare results to results from the literature. Two 4-hour sessions in successive weeks. Sessions on Monday 16 Jan. are rescheduled to Friday 13 Jan. due to the holiday.

3. Lab 2 (Weeks of 29 Jan. and 5 Feb.): **Forebodies at High Angle of Attack.** Place ogive cylinder in water tunnel at high angle of attack. Visualize vortex shedding with dye. Vary flow speed and angle of attack. Operate Laser Doppler Velocimeter. Measure profiles of velocity across vortex, mean and rms. Compare results to results from literature. Two 4-hour sessions in successive weeks.

4. Lab 3 (Weeks of 12 Feb. and 19 Feb.): **Shock/Boundary-Layer Interaction at Mach 2.0.** Run empty tunnel and get pressure distribution. Put wedge in blank in supersonic tunnel, using Mach-2.0 nozzle. Repeat, check pressure distribution. Connect Kulite pressure sensors to pressure taps on centerline near compression corner (disconnect from tunnel and plug). Measure mean and fluctuations in pressure distribution at different tunnel pressures. Use oil flow on floor of tunnel, photograph to look for separation. Obtain Schlieren images. Compare. Two 4-hour sessions in successive weeks.

5. Project, 8 weeks. Instructor will suggest some possible topics, with the assistance of other interested faculty. Student-initiated topics are welcomed and encouraged, and may be performed on the lab equipment or in other laboratories where students may work, with approval of the relevant professors. Students form small groups, propose topics for approval by instructor, research background information, design experiments, develop apparatus and perform measurements, analyze the data, iterate the process, and write up the results in a final report. Oral presentations are also to be made.

Academic Integrity

Students are reminded of the Student Code of Honor that states: "The purpose of the Purdue University academic community is to search for truth and to endeavor to communicate with each other. Self-discipline and a sense of social obligation within each individual are necessary for the fulfillment of these goals. It is the responsibility of all Purdue students to live by this code, not out of fear of the consequences of its violation, but out of personal self-respect. As human beings we are obliged to conduct ourselves with high integrity. As members of the civil community we have to conduct ourselves as responsible citizens in accordance with the rules and regulations governing all residents of the state of Indiana and of the local community. As members of the Purdue University community, we have the responsibility to observe all University regulations.

To foster a climate of trust and high standards of academic achievement, Purdue University is committed to cultivating academic integrity and expects students to exhibit the highest standards of honor in their scholastic endeavors. Academic integrity is essential to the success of Purdue University's mission. As members of the academic community, our foremost interest is toward achieving noble educational goals and our foremost responsibility is to ensure that academic honesty prevails." Code of Honor

Academic dishonesty will result in a zero for that assignment/exam and may result in a failing grade for the class. Furthermore, for all cases of academic dishonesty a report will be submitted to the Office of the Dean of Students, which may result in further disciplinary action. For more information go to: Office of Student Rights and Responsibilities

Regarding Protect Purdue:

The Protect Purdue Plan, which includes the Protect Purdue Pledge, is campus policy and as such all members of the Purdue community must comply with the required health and safety guidelines. Protect Purdue guidance continues to be updated as guidance and protocols evolve; please see Protect Purdue Updates for the latest updates.