

**General Information for A&AE 520  
Experimental Aerodynamics  
Prof. Steve Schneider, Spring 2020**

**Catalog Description of Course:**

A&AE 520, Experimental Aerodynamics, Class 2, lab 2, 3 credits. Prerequisite: A&AE 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:**

If there are more than 20 students enrolled, the following schedule may need to be modified in order to accommodate 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).

Spring 2020 is to be the last time this course is taught by Prof. Schneider. Prof. Jewell is to take 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. 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.

**Professor:** Steve Schneider

Aerospace Sciences Lab (ASL) Room 13C, 49-43343, email [steves@purdue.edu](mailto:steves@purdue.edu)

Usually at lab, seldom at Armstrong

Email, call, or visit lab.

**T.A.:** A. Carson Lay, [lay7@purdue.edu](mailto:lay7@purdue.edu), AERO Room 4

**Grading:** 3 preplanned labs, 50% total. Project, 50%. In the event of a major campus emergency, 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.

Interested students may replace one of these labs with a detailed study of a wind-tunnel balance, Contact Prof. Schneider if interested.

1. Warmup lectures, week 1, orientation and scheduling.
2. Lab 1 (Weeks of 20 and 27 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 20 Jan. will need to be rescheduled due to the holiday.
3. Lab 2 (Weeks of 3 and 10 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 17 and 24 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, 7 weeks. Instructor will suggest some possible topics, with the assistance of other interested faculty. Student-initiated topics are welcomed. 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.