General Information for A&AE 519  
Hypersonic Aerothermodynamics  
Prof. Steve Schneider Spring 2024

Catalog Description of Course:
A&AE 519, Hypersonic Aerothermodynamics, 3 credits. Prerequisites: A&AE 334 or equivalent, and MA 303 or 304.


Class Hours: MWF TBD. Also EPE online. Schneider expects to be on travel at several hypersonics meetings. Schneider expects to be on travel at AIAA SciTech during 7-12 January 2024, so the first actual class is to be after the M.L. King holiday on Monday 15 Jan. Lectures will be cancelled or made up as needed, with details to be arranged later. Two 2-hour evening exams are to be scheduled, each requiring cancellation of two class periods, during times when Prof. Schneider is on travel. The class will be informed via email.

Professor: Steve Schneider  
Aerospace Sciences Lab Room 13C, 49-43343, email steves@purdue.edu  
Armstrong Hall Room 3216, 49-45254  
Campus Office Hours: TBD, ARMS 3216  
Otherwise, email, call, or visit lab, or meet me before or after class.

T.A.: TBD. We are hope to get a good half-time TA who has taken the course before and done well. We also seek additional TA support, if a good person can be found.

Solution sets will be handed out, and homework will be graded on a 1-10 scale. If good TA support is available, more feedback will be provided. The TA will hopefully also hold office hours to help answer questions - should these be in-person or via Teams?

Grading: Problem sets, 25%. Two (evening) midterm exams: 25% each. Final exam, 25%. Please note that many problem sets will involve the use of existing FORTRAN codes, and thus require the students to develop an introductory understanding of that programming language. A project may be substituted for the final exam on student request, with topics to be approved by the instructor.


Some References:


**Scope:** The text and references are well-respected books that present the relevant technical background. A thorough understanding of all of this material is far beyond the scope of this course. In addition, some supersonic and low-speed viscous-flow methods must be covered, to provide sufficient preparation. Thus, this course can only serve as an introduction. The fundamental physical phenomena will be introduced, along with some of the methods used for analysis. A few selected areas will be covered in some depth. The course is intended to prepare the student to carry out further studies of particular topics as needed.

**Delivery Modes:** About 3/5 of the course involves blackboard lectures describing analytical derivations for relatively simple topics that can be understood in much more detail. PDF’s of the instructor’s notes are available on the course website.

About 2/5 of the course involves lectures from slides that describe more complex phenomena. PDF’s of these slides are also available on the course website.

Digital audio recordings of all lectures are to be provided to distance-learning students. There will be no video recordings.
Outline:
The following lists topics in the order in which they are to be covered. The relevant sections of the various references are cited.


4. **Introduction to Physical Chemistry of Gases**: Thermodynamics of reacting gases. Statistical mechanics and kinetic theory. Anderson Chap. 9-12, Vincenti and Kruger Chap. 1-5 + 9, Bird Chap. 1-6. Time constraints will allow us to provide only a very brief overview. The chemistry of reacting gases is covered in some depth in AAE439 and AAE539, in Prof. Poggie’s Nonequilibrium Hypersonic Flow course, and in ME501.

5. **High-Enthalpy Gasdynamics**: Hypersonic flows with chemical reaction effects. Equilibrium flow. Stagnation point heating. Anderson Chap. 13-18, Bertin (various sections), Vincenti and Kruger Chap. 6-8 and 10-12. This is a large and complex topic. Here, only equilibrium flow will be covered in any depth. The thermodynamics of equilibrium air will be presented without derivation and used to discuss stagnation point flow. This section will provide only an overview. Take Poggie’s course to cover more detail.

6. **Rarefied Gasdynamics**: Collisionless flows. The newtonian free-molecular approximation. Direct Simulation Monte Carlo techniques. Application to high-altitude aerodynamics and the gasdynamics of satellite thrusters. Bird Chap. 7-16. Beginning in 2007, this section has been reduced to a lecture or two. Persons interested in rarefied flows should take Prof. Alexeenko’s course.