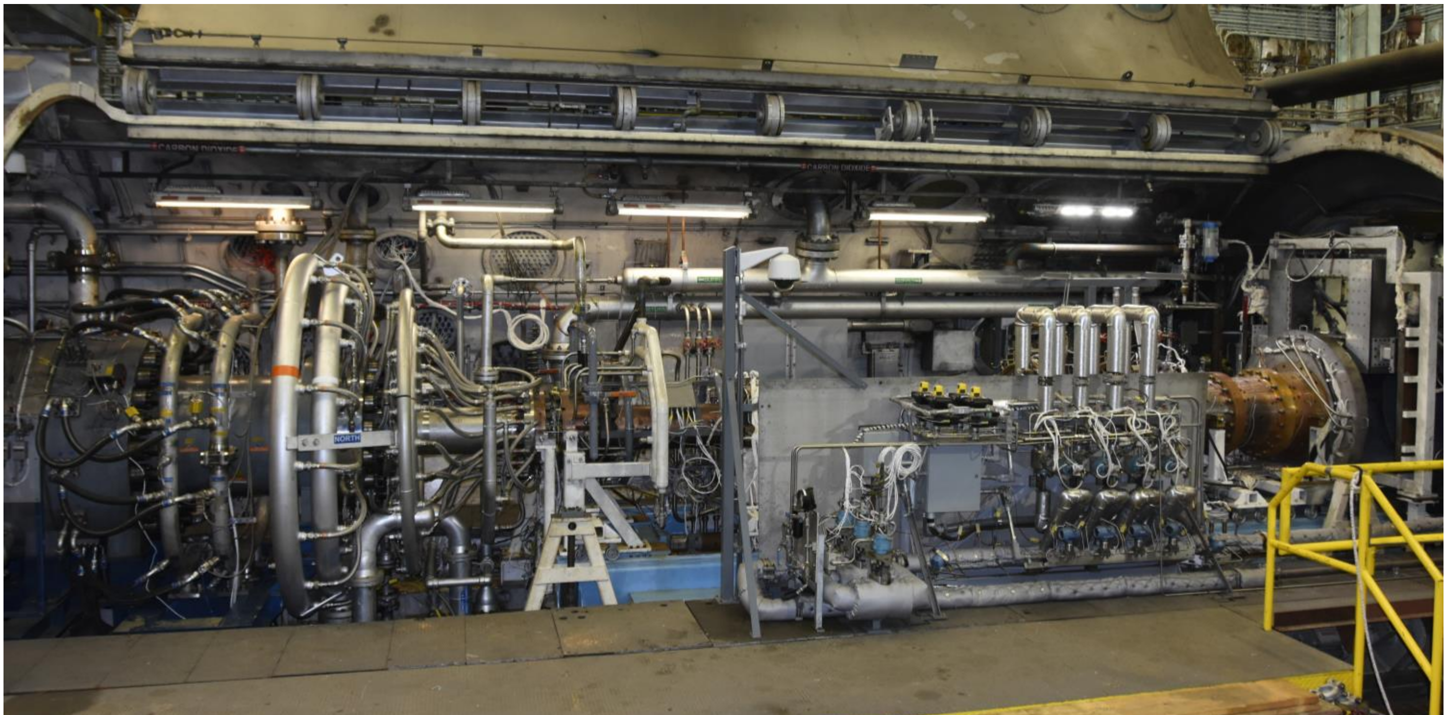
San José State University
Aerospace Engineering
AE280 – Hypersonics – Spring 2020



AEDC Aerodynamic and Propulsion Test Unit
Courtesy: Air Force (https://www.wpafb.af.mil/News/Photos/igphoto/2002166487/)

Instructor:	Prof. Fabrizio Vergine
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Office Hours:	Wednesday: 1:00pm – 3:00pm Thursday: 2:30pm – 3:30pm
Class Days/Time:	Tuesday and Thursday / 4:30pm – 5:45pm
Classroom:	ENG401
Prerequisites:	Graduate standing or instructor consent

Faculty Web Page and MYSJSU Messaging

Course materials such as syllabus, handouts, notes, assignment instructions, etc. can be found on the Canvas Leaning Management System course login website at http://sjsu.instructure.com. You are responsible for regularly checking with the messaging system through MySJSU at http://my.sjsu.edu.

Course Description

Fundamental principles of hypersonic aerodynamics. Development of important theory and techniques, discussion of salient results with emphasis on physical aspects, and presentation of modern thinking on the subject.

Course Goals

Introduce students to:

- *The fundamentals of hypersonic flight.*
- *The thermo-physics of reacting flows.*
- *Aerothermodynamics.*
- *External hypersonic aerodynamics.*
- *Aerodynamic heating on hypersonic vehicles.*
- *Principles of hypersonic and entry vehicle design.*

Course Learning Outcomes (CLO)

Upon successful completion of this course, students will be able to:

1) *Explain the physical phenomena and challenges of hypersonic flight.*
2) *Calculate the composition of a mixture of gases in thermo-chemical equilibrium.*
3) *Calculate the conditions downstream of normal and oblique shock waves as well as expansion waves in conditions of thermo-chemical equilibrium.*
4) *Estimate the exit conditions of the flow through a supersonic nozzle considering either equilibrium or frozen composition.*
5) *Calculate pressure, lift and drag coefficients on hypersonic vehicles using shock-expansion theory, Newtonian theory, modified Newtonian theory, tangent-wedge method.*
6) *Calculate skin friction drag on hypersonic vehicles.*
7) *Estimate aerodynamic heating on hypersonic vehicles.*
8) *Estimate peak and equilibrium stagnation point heat-flux on entry vehicles.*

Required Texts/Readings

Textbook

Anderson, J.D., Hypersonic and High-Temperature Gas Dynamics, 2nd edition, ISBN 978-1-563-47780-5

Other Readings

Instructor's notes posted on Canvas. Additional research material may be required for the completion of the project.

Course Requirements and Assignments

<u>Please note that some of the assignments (other than in-class midterm and final exams) may require the use of online resources/applets.</u>

Homework Assignments

Individual effort. Every assignment is due one week after the posting date. <u>The earned grade on assignments turned in within 24 hours from the due date/time will be penalized by 30%. Assignments turned in 24 or more hours late will not be accepted.</u>

Midterm Exam

Individual midterm examination. The exact date of the midterm will be communicated in class.

Individual Mini Projects

Two or three individual mini projects will be assigned during the course. Depending on the project, the due date may be two to three weeks after the posting date. Details will be communicated in class. The earned grade on assignments turned in within 24 hours from the due date/time will be penalized by 30%. Assignments turned in 24 or more hours late will not be accepted.

Comprehensive Final Exam

Individual final examination. The test may include any of the topics discussed in class.

"Success in this course is based on the expectation that students will spend, for each unit of credit, a minimum of 45 hours over the length of the course (normally 3 hours per unit per week with 1 of the hours used for lecture) for instruction or preparation/studying or course related activities including but not limited to internships, labs, clinical practica. Other course structures will have equivalent workload expectations as described in the syllabus."

Grading Information

- **Homework Assignments** 20%
- **Individual Projects** 20%
- **Midterm exam** 25%
- **Comprehensive Final Exam** 35%

A plus	> 97%
A	93% - 97%
A minus	90% - 92%
B plus	88% or 89%
B	83% - 87%
B minus	80% - 82%
C plus	78% or 79%
C	73% - 77%
C minus	70% - 72%
D	60% - 69%
F	< 60%

Classroom Protocol

No cellphone use is permitted in class. Respect for others is required and expected.

Academic Integrity

A student found guilty of academic dishonesty in any form (cheating, fabrication, plagiarism etc.) will automatically fail the course and will be reported to the Office of Student Conduct and Ethical Development.

University Policies

Per University Policy S16-9, university-wide policy information relevant to all courses, such as academic integrity, accommodations, etc. will be available on Office of Graduate and Undergraduate Programs' [Syllabus Information web page](http://www.sjsu.edu/gup/syllabusinfo/) at http://www.sjsu.edu/gup/syllabusinfo/.

AE Department and SJSU policies are also posted at http://www.sjsu.edu/ae/programs/policies/

Course Schedule

The schedule may be subject to change. Any changes will be notified with fair notice through official announcements both in class and on Canvas.

Week	Date	Topics, Readings, Assignments, Deadlines
1		**Introduction** - Definition of hypersonic regime. - Types of hypersonic vehicles.
2		**Introduction** - Velocity-altitude maps for lifting re-entry, ballistic re-entry and constant dynamic pressure flight. - Characteristics of hypersonic flows.
3		**High-temperature flows in equilibrium** - Review of thermodynamics for calorically perfect gases.
4		**High-temperature flows in equilibrium** - Thermodynamics of chemically reacting flows in equilibrium.
5		**High-temperature flows in equilibrium** - Law of mass action. - Calculation of the equilibrium composition of a mixture of perfect gases.
6		**Shock and expansion waves in hypersonic flow** - Iterative approach for shock and expansion waves calculations in a flow in equilibrium. - Equilibrium and frozen nozzle flows.
7		**Shock and expansion waves in hypersonic flow** - Mach number independence. - Hypersonic similarity parameter.
8		**Hypersonic aerodynamics** - Wedge and stagnation point solutions.
9		**Hypersonic aerodynamics** - Local inclination methods, Part I (Newtonian theory, modified Newtonian theory).
10		**Hypersonic aerodynamics** - Local inclination methods, Part II (tangent-wedge and tangent-cone methods, shock-expansion theory).
11		**Midterm exam (tentative date: 04/09)** **Viscous hypersonic flow** - Introduction to viscous flows.
12		**Viscous hypersonic flow** - Self-similar solutions for hypersonic laminar boundary layers (flat plate and stagnation point).

Week	Date	Topics, Readings, Assignments, Deadlines
13		**Viscous hypersonic flow** - Transition and turbulent boundary layers.
14		**Aerodynamic heating** - Fay-Riddell correlation for stagnation point heating.
15		**Aerodynamic heating** - Calculation of peak and equilibrium stagnation point heat-flux.
Final Exam	May 13	**Final exam** ENG401, from 02:45pm to 5:00pm