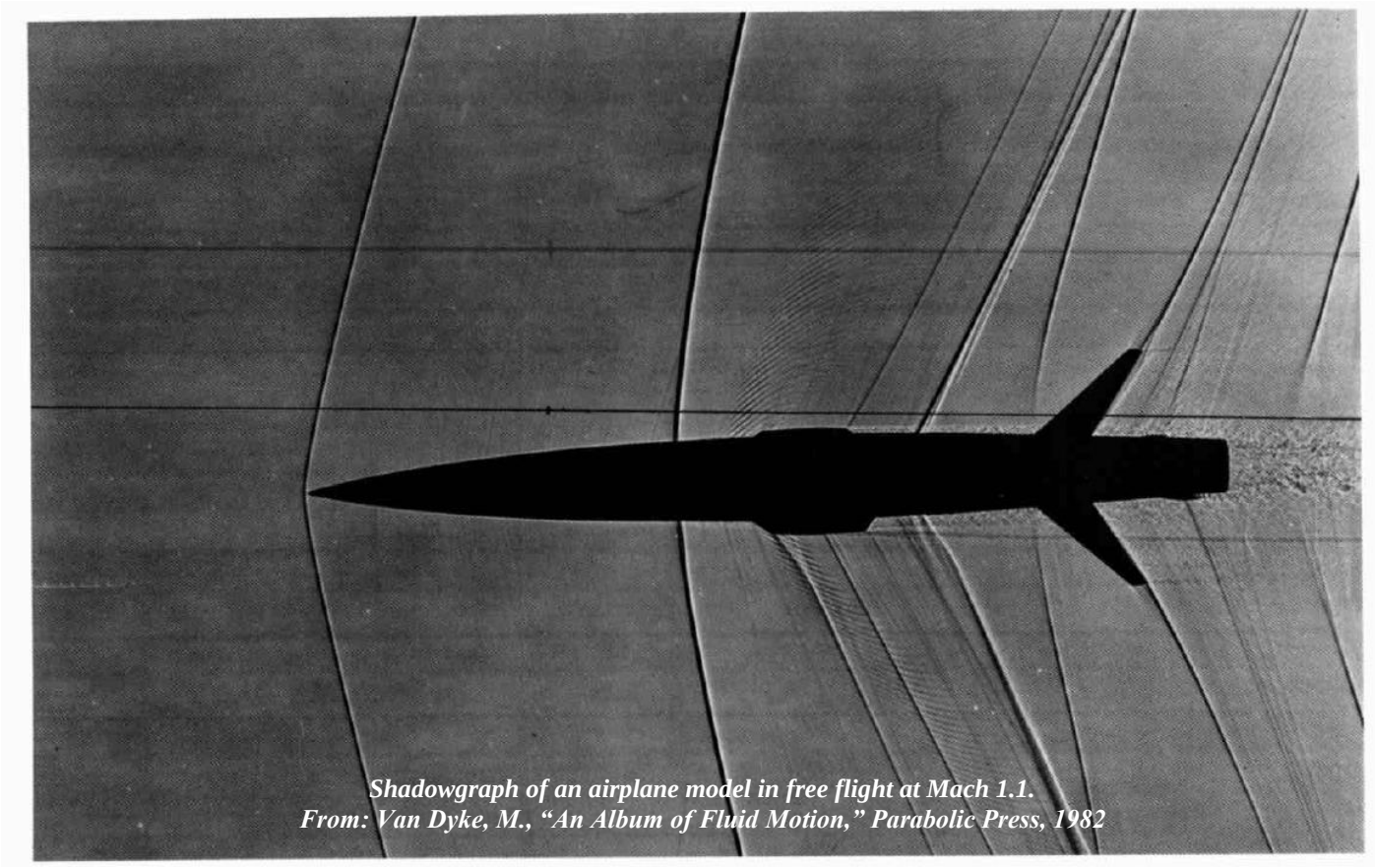
San José State University
Aerospace Engineering
AE264 – Gas Dynamics – Fall 2019



Shadowgraph of an airplane model in free flight at Mach 1.1.
From: Van Dyke, M., "An Album of Fluid Motion," Parabolic Press, 1982

Instructor:	Prof. Fabrizio Vergine
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Office Hours:	Tuesday and Thursday: 11:30am – 12:30pm Friday: 10:00am – 12:00pm
Class Days/Time:	Tuesday and Thursday / 4:30pm – 5:45pm
Classroom:	ENG340
Prerequisites:	Graduate standing in AE/ME 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

The course addresses advanced topics in compressible flow theory with emphasis on the design of high subsonic, supersonic and hypersonic vehicles. In addition to classical compressible flow theory and problem solving, the course may include supersonic wind tunnel experiments and computer simulations.

Course Goals

Introduce students to:

- *Modeling of internal and external high-speed flows.*
- *Estimation of the aerodynamic forces on a vehicle at high speeds.*
- *Aerodynamic design for high speed.*
- *Design of probes for high-speed flow measurements.*

Course Learning Outcomes (CLO)

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

1) *Define, explain, and use potential flow theory to study the flow around aerodynamic bodies at high speeds.*
2) *Calculate the conditions downstream of a system of reflected and refracted oblique shock waves through the use of the pressure-deflection diagrams.*
3) *Calculate surface pressure, lift, and drag of supersonic airfoils.*
4) *Explain classical and state-of-the-art high-speed flow measurement techniques.*
5) *Define, explain and use the Taylor-Maccol solution for supersonic conical flows.*
6) *Design in-stream probes for supersonic flow surveys.*
7) *Design a supersonic nozzle using the 2-D method of characteristics.*
8) *Calculate surface pressure, lift and drag of hypersonic vehicles.*
9) *Calculate viscous drag on supersonic and hypersonic airfoils.*

Required Texts/Readings

Textbook

Anderson, J. D., Modern Compressible Flow with Historical Perspective, 3rd edition, McGraw-Hill, ISBN 978-0072424430

Other Readings

- Anderson, J. D., Fundamentals of Aerodynamics, 6th edition, ISBN 978-1-259-12991-9
- Anderson, J. D., Hypersonic and High-Temperature Gas Dynamics, 2nd edition, ISBN 978-1-563-47780-5
- Instructor's notes posted on Canvas. Additional research material may be required for the completion of the project.

Course Requirements and Assignments

The course will include both individual (i.e., homework assignments, one midterm and one final exam) and group assignments (i.e., mini projects). Please note that some of the assignments (other than in-class midterm and final exams) may require the use of online resources and/or applets. Additional tools such as Matlab or Microsoft Excel or any similar software will be needed during the course.

Homework

Individual efforts. Approximately 5 or 6 assignments during the semester. Each student must submit his/her own individual solutions. Every assignment is due one week after the posting date if not otherwise specified by the instructor and will be collected at the beginning of class on the due date. Occasionally students may begin working on the assignments during class time under the supervision of the instructor.
Policies:

- *Assignments turned-in with unclear writing, unclear steps and/or unprofessional plots (when required) will not be graded.*
- *No late homework assignments will be accepted.*
- *No remedial homework will be given.*

Mini Projects

Groups of two students will be required to solve computationally-intensive tasks. Approximately 3 or 4 assignments during the whole semester. Every assignment is due one to two weeks after the posting date if not otherwise specified by the instructor and will be collected at the beginning of class on the due date. Some of these activities may be conducted during class time. Only one solution paper will be submitted.
Policies:

- *Assignments turned-in with unclear writing, unclear steps and/or unprofessional plots (when required) will not be graded.*
- *Each member of the group must provide a paragraph with a wet signature describing the work accomplished by him/her. Failure to do so will result in a zero in the assignment to that member.*
- *No late assignments will be accepted.*
- *No remedial work will be given.*

Midterm Exam

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

- *Specific rules for the exam will be communicated in class and posted on Canvas on the day of the announcement.*
- *No make-up midterm exams will be granted.*
- *In case of absence, a make-up exam may be granted at the instructor's discretion only in these cases:*
  - the absence is justified by a letter signed by a medical doctor in case of illness;
  - the absence is justified by a signed supervisor's statement, in case of work duties.

Comprehensive Final Exam

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

- *Specific rules for the exam will be communicated in class and posted on Canvas on the day of the announcement.*
- *No make-up final exams will be granted.*

"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%
- **Mini 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 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	08/22	**Introduction**
2	08/27 – 08/29	**Review of Incompressible Potential Flow Theory** - Basic flow kinematics. - Incompressible potential flows.
3	09/03 - 09/05	**Compressible Potential Flows** - Linearized subsonic flows. - Compressibility corrections to incompressible potential flows. - Linearized supersonic flows.
4	09/10 - 09/12	**Review of Supersonic Aerodynamics I** - Isentropic flows. - Shock and expansion waves.
5	09/17 - 09/19	**Shock Interactions in 2-D flows I** - p-θ diagrams, shock polar. - Refracted shocks of the same family.
6	09/24 – 09/26	**Shock Interactions in 2-D flows II** - Refracted shocks of opposite families.
7	10/01 - 10/03	**Aerodynamic Forces Calculation on Supersonic and Hypersonic Vehicles** - Shock-Expansion Theory. - Tangent-Wedge Method.
8	10/08 - 10/10	**Axisymmetric Supersonic Flows** - Taylor-Maccol solution for conical flows.
9	10/15 - 10/17	**Measurement Techniques in Supersonic Flows.** - Classical measurements: Schlieren imaging, in-stream probes. - Particle Image Velocimetry.
10	10/22 - 10/24	**Midterm Exam (tentative date: 10/22/2019)** **Review of Supersonic Aerodynamics II** - Quasi 1-D flows (nozzles and diffusers).
11	10/29 - 10/31	**Method of Characteristics for Steady 2-D Flows I** - Solution technique for Euler equations.
12	11/05 - 11/07	**Method of Characteristics for Steady 2-D Flows II** - Minimum length supersonic nozzle design. - Supersonic nozzle design with smooth expansion section.
13	11/12 - 11/14	**Method of Characteristics for Steady 2-D Flows III** - Expansion-shock wave interactions.
14	11/19 - 11/21	**Viscous compressible flow I** - Compressible boundary layer equations.
15	11/26 - 12/05	**Viscous compressible flow II** Boundary layer equations solution for flat plates.
Final Exam	Tuesday, Dec 17	**Final exam** ENG330, from 02:45pm to 5:00pm