San José State University
Aerospace Engineering
AE 164, Aerothermodynamics, Fall 2020

Course and Contact Information

Instructor:	Prof. Fabrizio Vergine
Office Location:	E272B
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Email:	fabrizio.vergine@sjsu.edu
Office Hours:	Tuesday and Thursday, from 3:00pm to 4:00pm *Please follow the ZOOM link below to access office hours*: https://sjsu.zoom.us/j/91865399529
Class Days/Time:	Tuesday, Wednesday, Thursday, 1:00pm – 2:25pm
Classroom:	Online. *Please follow the ZOOM link below to access Tuesday and Wednesday lectures (see on Canvas for more options)*: https://sjsu.zoom.us/j/93604935267?pwd=cVRtVTRaMTVJWHlHZ2ZCdDlia2cxdz09 Passcode: 262481 *Please follow the ZOOM link below to access Thursday's workout lectures*: https://sjsu.zoom.us/j/96279105894?pwd=S1FLVUNzSThDOFZEZFQyNU8xdy8vQT09 Passcode: 896365
Prerequisites:	Grade of "C" or better in PHYS 052 and AE 160 or graduate standing

Course Format

Faculty Web Page and MYSJSU Messaging

Course materials such as syllabus, handouts, notes, assignment instructions, etc. can be found on Canvas Learning Management System course login website at http://sjsu.instructure.com. You are responsible for regularly checking the email address listed in your MySJSU at http://my.sjsu.edu profile and the Canvas Inbox to learn of any updates.

Course Description

Thermodynamic laws. Shock and expansion waves with applications to supersonic airfoils and wings. Nozzle flow. Flow with heat addition and friction. Aerodynamic heating. Conduction, convection and radiation heat transfer.

Course Goals

Introduce students to:

- *Accounting for energy and determining the efficiency of thermodynamic processes.*

- *Modeling of internal and external high-speed flows.*
- *Estimation of the aerodynamic forces on super/hypersonic vehicles.*
- *Estimation of aerodynamic heating on super/hypersonic vehicles.*
- *Aerothermodynamic design principles for super/hypersonic vehicles.*

Course Learning Outcomes (CLO)

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

1) *Use the 1st and 2nd laws of thermodynamics to calculate heat transfer, work done and entropy changes in a thermodynamic system.*
2) *Use the equation of state and the definition of enthalpy to calculate thermodynamic properties.*
3) *Calculate the isothermal and isentropic compressibility of a gas for given conditions.*
4) *Use thermodynamics and conservation equations to calculate flow parameters at various points of a flow field.*
5) *Calculate stagnation and critical conditions at various points of a flow field for isentropic flow, adiabatic flow, flow with heat addition and flow with friction.*
6) *Explain physically what happens to flow parameters when the flow (a) crosses a normal shock wave, (b) is heated or cooled and (c) is subjected to friction.*
7) *List the differences between a Mach wave and a shock wave.*
8) *Explain the conditions under which you get (a) a bow shock in front of a body or a compression corner, and (b) an oblique shock at the nose of a body or at a compression corner.*
9) *Explain the differences between the flow over a cone and the flow over a wedge.*
10) *Calculate the flow properties downstream of a Mach wave, an oblique shock wave, and a Prandtl-Meyer expansion wave.*
11) *Calculate the lift and drag on supersonic airfoils using shock-expansion theory.*
12) *Calculate the flow properties downstream of a reflected / refracted shock wave.*
13) *Explain mathematically and physically the relationship between flow cross-sectional area and local Mach (or flow speed).*
14) *Explain an (a) ideally expanded, (b) over-expanded and (c) under-expanded nozzle.*
15) *Calculate the flow properties at various locations of an (a) ideally expanded, (b) over-expanded and (c) under-expanded nozzle.*
16) *Calculate the location of a shock in a Laval nozzle (assuming there is one).*
17) *Design a supersonic / hypersonic wind tunnel (i.e. select the appropriate reservoir, throat and nozzle exit conditions to get the desirable test section conditions).*
18) *Identify when heat transfer occurs as conduction, convection, or radiation.*
19) *Setup and solve conduction problems using Fourier's Law.*
20) *Explain the difference between natural and forced convection, and the tradeoffs associated with them.*
21) *Setup and solve convection problems using Newton's Law of Cooling.*
22) *Estimate aerodynamic heating on supersonic and hypersonic vehicles.*
23) *Select appropriate nose shapes for different Mach numbers, and explain the tradeoffs associated with the different shapes.*
24) *Work effectively in a team to define and solve open-ended problems that combine compressible flow and jet / rocket engine performance.*

Course Relationship to BSAE Program Outcomes

	A	B	C	D	E	F	G	H	I
Learning Outcomes									
1 – 24	++	O		O	O			O	O

+: Skill level 1 or 2 in Bloom's Taxonomy
++: Skill level 3 or 4 in Bloom's Taxonomy
+++: Skill level 5 or 6 in Bloom's Taxonomy
O: Skill addressed but not assessed

Required Texts/Readings

Textbook

Anderson, J.D., Fundamentals of Aerodynamics, 6th edition, ISBN 978-1-259-12991-9

Other Readings

Instructor's slides posted on Canvas. Additional research material will be required for the completion of the final project.

Other technology requirements / equipment / material

- A computer with internet connectivity and the video conferencing software ZOOM is required. Please follow this link for more information to set it up: https://ischool.sjsu.edu/zoom

- Basic proficiency with Microsoft Excel, Matlab or any other programming tools is encouraged. Matlab can be freely accessed from the computers in College of Engineering through VPN (for details on how to setup the Cisco VPN client on your PC use the following link: https://www.sjsu.edu/it/services/network/vpn/index.php). Microsoft Excel is part of the Office 365 package that SJSU provides for free to all students (for more details use the following link: https://www.sjsu.edu/it/services/collaboration/software/instructions.php). Additional ways of accessing the software may be available. For more information contact the IT department.

- Some assignments may require you to have a working webcam. Please make sure you have access to one.

Course Requirements and Assignments

Homework

Individual assignments. Note that homework will be assigned to allow students to prepare for in-class workouts. The assignments will not be graded, however they must be turned in and show enough effort in order to receive a grade in the related workout. Homework assignments will be due at the beginning of the lecture of a workout day.

Workouts

Workout days will follow the typical approach of a "flipped" classroom, for which students are required to come to lecture prepared on the topics and problems that the professor instructed them to study/deepen/solve at the time of assignment of the homework.

Workouts are group efforts which will tentatively be held weekly on Thursdays (exact dates and times of the workouts will be communicated during lecture), for a total of approximately 11 assignments during the semester. Assigned problems will be solved during class time by groups of 4 students and must be turned-in at the end of the meeting unless differently specified by the instructor. If not typed, the assignment should be clearly hand-written and in any case it must include all the pertinent information (assumptions, explanation of steps, equations, etc.). Each individual in a group will receive the same grade as the group as a whole provided that he or she submitted the homework assignment related to the workout.

Policies:

- *Attendance will be taken on the day of the workout. Students who are absent will receive a zero in the assignment regardless of the homework's submission.*
- *Each member of the group must provide a short paragraph 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 and no remedial work will be given unless documentation of a compelling reason for not being able to complete the work in time or not being in class during the workout is provided.*

During workout days, students will be divided into "breakout rooms" of 4 members (i.e., the same members of a group). The instructor and the TA will enter each room regularly to provide answers to questions and help. The instructor may temporarily "break" the rooms to provide explanations to the whole class, if needed.

Midterm exams

Two individual midterm examinations. The exact dates of the midterms will be communicated in class.
Policies:

- *Specific rules for the midterm will be communicated in class and posted on Canvas on the day of the announcement.*
- *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.

Project

Teams of 4 students will be assigned an aerothermodynamics topic with application in a real-life supersonic aircraft or wind tunnel facility. All groups must submit:

- *A written midterm report (dates and times TBD).*
- *A final written report due on the last day of class.*
- *A presentation of the work (dates and times TBD).*

Each individual in a group will receive the same grade as the group as a whole.

Policies:

- *Projects must be typed.*
- *Each member of the group must provide one page describing the work accomplished by him/her throughout the semester. Failure to do so will result in a zero in the project to that member.*
- *No late assignments will be accepted unless documentation of a compelling reason for not being able to complete the work in time is provided.*

Final Exam

Individual, comprehensive final examination.
Policies:

- *Specific rules for the exam will be communicated in class and posted on Canvas on the day of the announcement.*
- *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.

"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

Determination of Grades

-	***Workouts***	*15%*
-	***Midterm exam 1***	*20%*
-	***Midterm exam 2***	*20%*
-	***Final exam***	*30%*
-	***Project***	
	Midterm report	*1%*
	Final report	*10%*
	Final presentation	*4%*

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%

Recording Zoom Classes

This course or portions of this course (i.e., lectures, discussions, student presentations) will be recorded for instructional or educational purposes. The recordings will only be shared with students enrolled in the class through Canvas. The recordings will be deleted at the end of the semester. If, however, you would prefer to remain anonymous during these recordings, then please speak with the instructor about possible accommodations (e.g., temporarily turning off identifying information from the Zoom session, including student name and picture, prior to recording).

Students are not allowed to record without instructor permission

Students are prohibited from recording class activities (including class lectures, office hours, advising sessions, etc.), distributing class recordings, or posting class recordings. Materials created by the instructor for the course (syllabi, lectures and lecture notes, presentations etc.) are copyrighted by the instructor. This university policy (S12-7, https://www.sjsu.edu/senate/docs/S12-7.pdf) is in place to protect the privacy of students in the course, as well as to maintain academic integrity through reducing the instances of cheating. Students who record, distribute, or post these materials will be referred to the Student Conduct and Ethical Development office. Unauthorized recording may violate university and state law. It is the responsibility of students that require special accommodations or assistive technology due to a disability to notify the instructor.

Proctoring Exams

Exams will be proctored in this course by the instructor and the teaching associate/s. Exam sessions will require use of a webcam and will be recorded. The recordings of the exam sessions will not be made available to students. Please note it is the instructor's discretion to determine the method of proctoring. If cheating is suspected the proctored videos may be used for further inspection and may become part of the student's disciplinary record. Students are encouraged to contact the instructor if unexpected interruptions (from a parent or roommate, for example) occur during an exam.

Online Exams Testing Environment

- No phones.
- No earbuds, headphones, or headsets visible.
- The environment should free of other people besides the student taking the test.
- If students need scratch paper for the test, they should present the front and back of a blank scratch paper to the camera before the test.
- Well-lit environment. Proctors should be able to see the students' eyes and their whole face. Avoid having backlight from a window or other light source opposite the camera.
- *The work must be hand-written on white paper only and scans must be submitted on Canvas at the end of the test.*

Classroom Protocol

- **Students will be muted upon entry in the Zoom meeting of each lecture**: but they can raise their hand electronically or unmute themselves at any time to ask questions, reply to questions and make comments.
- **Be mindful of background noise and distractions**: find a quiet place to "attend" class, to the greatest extent possible. Avoid video setups where people may be walking behind you, people talking/making noise etc. Avoid activities that could create additional noise, such as shuffling paper, listening to music in the background, etc.
- **Position your camera properly**: be sure your webcam is in a stable position and focused at eye level.
- **Limit your distractions/avoid multitasking**: you can make it easier to focus on the meeting by turning off notifications, closing or minimizing running apps, and putting your smartphone away (unless you are using it to access Zoom).
- **Use appropriate virtual backgrounds**: if using a virtual background, it should be appropriate and professional and should NOT suggest or include content that is objectively offensive or demeaning.

Technical difficulties

Internet connection issues:
Canvas autosaves responses a few times per minute as long as there is an internet connection. If your internet connection is lost, Canvas will warn you but allow you to continue working on your exam. A brief loss of internet connection is unlikely to cause you to lose your work. However, a longer loss of connectivity or weak/unstable connection may jeopardize your exam.
Other technical difficulties:
Immediately email the instructor a current copy of the state of your exam and explain the problem you are facing. Your instructor may not be able to respond immediately or provide technical support. However, the copy of your exam and email will provide a record of the situation.

Contact the SJSU technical support for Canvas:

Technical Support for Canvas Email: ecampus@sjsu.edu Phone: (408) 924---2337 https://www.sjsu.edu/ecampus/support/

If possible, complete your exam in the remaining allotted time, offline if necessary. Email your exam to your instructor within the allotted time or soon after.

Academic Integrity

Students who are suspected of cheating during an exam will be referred to the Student Conduct and Ethical Development office and depending on the severity of the conduct, will receive a zero on the assignment or a grade of F in the course. Grade Forgiveness does not apply to courses for which the original grade was the result of a finding of academic dishonesty.

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/

AE 164, Aerothermodynamics, Fall 2020, 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.

Course Schedule

Week	Topics, Readings, Assignments, Deadlines
1	Fundamentals of thermodynamics
2	Fundamentals of thermodynamics
3	Control Volume Analysis
4	1D compressible flows: total and critical quantities, speed of sound
5	1D adiabatic compressible flows: normal shocks
6	1D non-adiabatic, inviscid compressible flows: Rayleigh flow
7	**Midterm Exam 1 (tentative date: Thursday, October 8 2020 during class time)** 1D adiabatic viscous compressible flows: Fanno flow
8	2D adiabatic supersonic flows: oblique shocks
9	2D isentropic supersonic flows: Prandtl-Meyer expansion waves
10	Supersonic airfoil theory
11	Quasi 1D flow: de Laval nozzles, diffusers and supersonic wind tunnels
12	**Midterm Exam 2 (tentative date: Thursday, November 12 2020 during class time)** Heat transfer: conduction
13	Heat transfer: convection
14	Heat transfer: radiation
15	Elements of hypersonic flows
Final Exam	**Final Exam** Monday, December 14, from 12:15pm to 14:30pm