San José State University
College of Engineering/Aerospace Engineering
AE 164, Aerothermodynamics, 01, Fall, 2022

Course and Contact Information

Instructor:	Yawo Ezunkpe, Ph.D.
Office Location:	E272 B and/or Online/Zoom
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Email:	yawo.ezunkpe@sjsu.edu
Office Hours:	Tuesday and Thursday, from 1:30pm to 2:30pm.
Class Days/Time:	Tue, Wed, and Thur. 3:00 pm – 4:25 pm
Classroom:	Sweeney Hall 100 (SH 100) Canvas - https://sjsu.instructure.com/courses/1488431

Prerequisites and Recommended Preparation:
The course pre-requisites are PHYS 052 and AE 160 with a grade of C or better in each course, or Equivalent, or graduate standing.

Course Description and Objectives

This course deals with the thermos-fluid dynamic problem. The course content emphasizes on 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 Format

This course is taught in Canvas. To access our course, log in via One.SJSU. This class will meet in person every Tuesday, Wednesday, and Thursday.
Questions about Canvas are best handled by Canvas Support (chat: ecampus@sjsu.edu and 408-924-2337 and technical support: https://www.sjsu.edu/ecampus/support), although I will try to assist you with technical questions when possible. The Canvas Guides are an excellent resource for you as well.

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 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 (CLOs)

Students who successfully complete this course 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. *Select appropriate nose shapes for different Mach numbers, and explain the tradeoffs associated with the different shapes.*
23. *Work effectively in a team to define and solve open-ended problems that combine compressible flow and jet / rocket engine performance.*

Required Texts/Readings

Textbook

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

Other Readings

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

Other technology requirements / equipment / material

- 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

- In one or two occasions, some class activities may require you to use a Virtual/ Augmented reality (VR, AR) or Extended reality (XR). In those instances, you will be given specific instructions and tools to successfully complete the activities.
- Questions about Canvas are best handled by Canvas Support (chat: ecampus@sjsu.edu and 408-924-2337 and technical support: https://www.sjsu.edu/ecampus/support), although I will try to assist you with technical questions when possible. The Canvas Guides are an excellent resource for you as well

Course Requirements and Assignments

Homework

There will be Individual and/ or group homework assignments. Note that homework will be assigned to allow students to prepare for in-class work, tests and quizzes. Some of the assignments may not be graded; however, they must be turned in and show enough effort to receive a grade in the related workout. Homework assignments must be submitted by the due date. Homework delivered after the due date will not be accepted.
Note: *Homework problems will be posted on canvas with problems relevant to the lectures that are important, interesting, and challenging. The problems may reflect questions on the exams/quizzes. You are encouraged to work with others on homework assignments but be sure that you can solve the problems on your own for the tests.*

Workouts

Workouts are group efforts which will tentatively be held weekly in classroom (exact times of the workouts may vary during lecture), for a total of approximately 6 to 8 group assignments during the semester. Assigned problems will be solved during class time by groups of 3 to 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.). The simple act of trying to answer questions (even if you're unsuccessful) will help with your recall of material and understanding of the course, and that will help on the quizzes and final exams. Everyone in a group will receive the same grade as the group, provided that the student submitted the homework assignment related to the workout

Policies:

- You are expected to attend each meeting of the class for which you are registered, except when absence cannot be prevented for reasons beyond your control. Therefore, regular attendance and class participation is as vital in this remote class as it is in a traditional classroom. Your presence will be

counted not only by taking roll, but also by your regular contributions/participation in academically related activities for this course (activities including, but not limited to, submitting an assignment, taking a quiz, participating in an online discussion, and working in a group). You will be considered absent if there is no evidence of your participation in the academic activities of this course.

- 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.
- Assignments for this course should be completed and submitted on time so that we all move through the class together. Sometimes, though, life gets in the way of learning. In unexpected situations leading to late work, please contact me to discuss a plan for success.
- During workout, students will be divided into group of 4 members (i.e., the same members of a group). The instructor will be available to answer questions and provide guidance, help. The instructor may temporarily "break" the groups to provide explanations to the whole class, if needed.

Tests/Quizzes:

We will have a total of five (5) quizzes (mini tests). They will cover the previous lessons as well as assigned readings (textbook chapters and problems) and homework assignments and In-class activities.

They will be given on the dates of the shown on this syllabus and the dates are tentative.

Policies:

- *Specific rules for the tests 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

This is a group effort. Teams of 4 students will pick or be assigned open-ended design problem in aerothermodynamics topic with application in a real-life.

All groups must submit:

- A final written report due on the last day of class must include:
    - A clear and thorough description of all the steps taken towards the solution
    - Plots and graphs must be commented and well presented with appropriate labels
    - A clear conclusion or recommendation
- A presentation of the work (dates and times TBD).

Everyone in a group will receive the same grade as the group.

Policies:

- *Projects must be typed following one of the professional Engineering report formats (AIAA, EIEE etc..).*
- *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 Examination

It will be Individual and comprehensive final examination.

Policies:

- *Specific rules for the exam will be communicated in class and posted on Canvas on the day of the announcement.*
- *Neither rescheduled nor make-up exams will be allowed unless a written verification of a valid excuse (such as hospitalization, family emergency, religious observance, court appearance, etc.) is provided.*

Grading Information

Each student's final grade is calculated by the percentage of total points possible earned by that student, using a standard scale:

Grades	Percentages
A *plus*	97 +
A	93 to 97
A *minus*	90 to 93 -
B *plus*	88 to 90 -
B	83 to 88 -
B *minus*	80 to 83 -
C *plus*	78 to 80 -
C	73 to 78 -
C *minus*	70 to 73 -
D	60 to 70 -
F	60 -

The instructor reserves the right to add/change/delete points during the semester.

Assignment	**% Of Total**
Homework	5%
Quizzes	45%
Workouts	10%
Final Exam	20%
Project	20%
Total Possible	**100%**

Course Schedule (TENTATIVE)

There will be three lectures per week, five quizzes (mini tests), and a comprehensive final exam.
The TENTATIVE lecture schedule for Fall 2022 is shown below:

Lesson	Date	Topic/ Reading	Assignments due date
0	19 Aug	Introduction	
1	23 Aug 24 Aug 25 Aug	Fundamentals of thermodynamics Fundamentals of thermodynamics Fundamentals of thermodynamics	Activities
2	30 Aug 31 Aug 01 Sep	Control Volume Analysis Control Volume Analysis Control Volume Analysis	WK Activities
3	06 Sep 07 Sep 08 Sep	1D compressible flows: total and critical quantities, speed of sound 1D compressible flows: total and critical quantities, speed of sound 1D compressible flows: total and critical quantities, speed of sound	HW Quiz 1
4	13 Sep 14 Sep 15 Sep	1D adiabatic compressible flows: normal shocks 1D adiabatic compressible flows: normal shocks 1D adiabatic compressible flows: normal shocks	WK
5	20 Sep 21 Sep 22 Sep	1D non-adiabatic, inviscid compressible flows: Rayleigh flow 1D non-adiabatic, inviscid compressible flows: Rayleigh flow 1D non-adiabatic, inviscid compressible flows: Rayleigh flow	HW
6	27 Sep 28 Sep 29 Sep	1D adiabatic viscous compressible flows: Fanno flow 1D adiabatic viscous compressible flows: Fanno flow 1D adiabatic viscous compressible flows: Fanno flow	WK, Quiz 3
7	04 Oct 05 Oct 06 Oct	2D adiabatic supersonic flows: oblique shocks 2D adiabatic supersonic flows: oblique shocks 2D adiabatic supersonic flows: oblique shocks	
8	11 Oct 12 Oct 13 Oct	2D isentropic supersonic flows: Prandtl-Meyer expansion waves 2D isentropic supersonic flows: Prandtl-Meyer expansion waves 2D isentropic supersonic flows: Prandtl-Meyer expansion waves	HW, WK
9	18 Oct 19 Oct 20 Oct	Supersonic airfoil theory Supersonic airfoil theory Supersonic airfoil theory	Quiz 3 WK
10	25 Oct 26 Oct 27 Oct	Quasi 1D flow: de Laval nozzles, diffusers, and supersonic wind tunnels Quasi 1D flow: de Laval nozzles, diffusers, and supersonic wind tunnels Quasi 1D flow: de Laval nozzles, diffusers, and supersonic wind tunnels	HW, WK
11	01 Nov 02 Nov 03 Nov	Heat transfer: conduction Heat transfer: conduction Heat transfer: conduction	Quiz 4
12	08 Nov 09 Nov 10 Nov	Heat transfer: convection Heat transfer: convection **Veteran's Day (No Class)**	WK
13	15 Nov 16 Nov 17 Nov	Heat transfer: radiation Heat transfer: radiation Heat transfer: radiation	HW, WK

14	22 Nov 23 Nov 24 Nov	Elements of hypersonic flows **No Class** **Thanksgiving Holiday (No Class)**	Quiz 5
15	29 Nov 30 Nov 01 Dec	Elements of hypersonic flows Elements of hypersonic flows Review for Final Exam	 HW
16	06 Dec 07 Dec	Last day of Class **Final Exam - TBA**	Projects (Reports due)

Recording Classes

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 (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 or the teaching associate/s.

- *A basic scientific calculator like the TI-30XIIs should be used during the examinations. Your calculator should have only basic functionality (no added bells or whistles). Students retain the freedom to use their calculator of choice on homework, labs, and projects; however, students are encouraged to practice using their exam calculator to make sure they fully understand its functionality. The reason for this is to address growing inequity and academic dishonesty issues due to different calculators used by students during exams.*
- *The use of PDAs, smartphones/iPhones, Blackberry-type devices, cell phones, tablet/laptop computers, or any other sources of communication (wireless or otherwise) are strictly prohibited during examinations. Doing so is unacceptable.* ***If you bring a cell phone or other communication device*** *to the examination,* ***it must be turned off prior*** *to the start of the exam****, stored below your seat****, and* ***only picked up as you leave*** *the examination room for the time. It cannot to be turned on again until after you have exited the examination room*

Office Hours and Communication

- *For email contact with the instructor, please put AE 164 first in the Subject box. Canvas Inbox (preferred method of contact) or yawo.ezunkpe@sjsu.edu*
- *My office hours are times for conversation about the course and your work in it. I am here to answer questions, offer feedback, discuss a course concept, or just listen as you explore a line of reasoning. I can also direct you to resources to help you meet challenges you face outside of class.*

- *I will try to respond to any academically related inquiries within one business day. Any inquiries sent over the weekend or on a holiday will be resolved on the following business day.*

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