San José State University
Aerospace Engineering Department
AE 265, Boundary Layers, Spring 2021

Course and Contact Information

Instructor:	Prof. Fabrizio Vergine
Office Location:	E272B
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Email:	fabrizio.vergine@sjsu.edu
Office Hours:	Monday, from 3:00pm to 4:00pm Tuesday, from 2:00pm to 3:00pm *Please follow the ZOOM link below to access office hours*: https://sjsu.zoom.us/j/82345024070
Class Days/Time:	Monday, Wednesday, 4:30pm – 5:45pm
Classroom:	Online. *Please follow the link below to register to the ZOOM meetings*: https://sjsu.zoom.us/meeting/register/tZwkce-vqzoqHtQfdU80wrJ0HTJ5rwmfv2wu Passcode: 765263
Prerequisites:	Graduate standing or instructor consent

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

Boundary layer analysis on airfoils and aerodynamic surfaces: integral methods (Pohlhausen, Thwaites-Walz). Self-similar solutions for laminar boundary layers: Blasius solution and Falkner-Skan flows. Explicit finite difference methods for the solution of incompressible, laminar boundary layers with and without external pressure gradients. Compressible, boundary layers: general solutions, self-similar solutions in supersonic and hypersonic flow regimes. Turbulent boundary layers: transition, universal law of the wall, turbulence models.

Faculty Web Page and MYSJSU Messaging

Course materials such as syllabus, handouts, notes, assignment instructions, etc. can be found on my faculty web page at http://www.sjsu.edu/people/firstname.lastname and/or on Canvas Learning Management System course login website at http://sjsu.instructure.com. You are responsible for regularly checking with the

messaging system through MySJSU on Spartan App Portal http://one.sjsu.edu (or other communication system as indicated by the instructor) to learn of any updates.

Course Goals

Introduce students to:

- Analysis of boundary layers over airfoils in subsonic flows.
- Analysis of boundary layers over aerodynamic surfaces in supersonic and hypersonic flows.
- Estimation of the viscous drag and flow-surface heat transfer on airfoils in all flow regimes.
- Laminar-to-turbulent boundary layer transition. Turbulence models for boundary layers.

Course Learning Outcomes (CLO)

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

1. Calculate the laminar boundary layer characteristics over subsonic airfoils using integral methods: boundary layer thickness, displacement thickness, momentum thickness, skin friction coefficient.
2. Estimate laminar boundary layer separation over airfoils in subsonic regime.
3. Solve the differential equations for a laminar boundary layer with and without a pressure gradient.
4. Calculate the laminar boundary layer characteristics over supersonic and hypersonic airfoils: boundary layer thickness, displacement thickness, momentum thickness, skin friction coefficient, Stanton number.
5. Solve the differential equations for a laminar boundary layer over a flat plate in supersonic/hypersonic regime.
6. Estimate the location of the laminar-to-turbulent transition point of a boundary layer.
7. Calculate the turbulent boundary layer characteristics over supersonic and hypersonic airfoils: boundary layer thickness, displacement thickness, momentum thickness, skin friction coefficient, Stanton number.
8. Calculate viscous drag and flow-surface heat transfer of laminar and turbulent boundary layers on airfoils in all flow regimes.

Required Texts/Readings

Textbook (Required)

J. Schetz and R. D. W. Bowersox*, "Boundary Layer Analysis",* second edition, AIAA Education Series, 2011. doi: 10.2514/4.868245

Other Readings

- Hypersonic Flows

Anderson, J.D., "*Hypersonic and High-Temperature Gas Dynamics*", second edition, AIAA Education Series, 2019.
doi: 10.2514/4.105142

- Basic Aerodynamics

Anderson, J.D., "*Fundamentals of Aerodynamics*", sixth edition, McGraw Hill, 2017.
ISBN-13: 978-1259129919

Any additional material such as journal papers or conference proceedings will be provided by the instructor.

Other technology requirements / equipment / material

A computer with internet connectivity will be necessary to solve some of the assignments. Free online tools may be used in conjunction with electronic spreadsheets. The use of Matlab, Microsoft Excel or any other programming tool is allowed, but not required. Matlab can be freely accessed from the computers in College of

Engineering, either in person or 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).

Course Requirements and Assignments

Homework Assignments

Individual effort. Every assignment is due one week after the posting date. 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 unless a signed doctor's or work supervisor's note demonstrating a compelling reason for not being able to complete the work in time is provided.

Midterm Exam

Individual midterm examination. The exact date of the midterm will be communicated in class. Makeup exam may be given if a signed doctor's or work supervisor's note or any signed document demonstrating a compelling reason for not being able to attend the exam is provided.

Individual Projects/Lab Reports

Depending on the lab availability, one experiment may be conducted in the subsonic and the supersonic wind tunnels located in the Aerodynamics laboratory of the Aerospace Engineering department. The experiment will be supervised and the students in groups of 4 will be required to provide an individual lab report. Details on the experiments will be communicated at the beginning of the course.

In the absence of the experiment, one individual project focused on more computationally-intensive aspects of boundary layer flows 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 unless a signed doctor's or work supervisor's note demonstrating a compelling reason for not being able to complete the work in time is provided.

Final examination

Individual, comprehensive 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 Project/Lab Report** 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%

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/Quizzes

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 automatically saves 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 265 / Boundary Layers, Spring 2021, 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	Date	Topics, Readings, Assignments, Deadlines
1		**Introduction to viscous flows** - Concept of boundary layer - Boundary layer equations - Separation - Non-Newtonian fluids
2		**Integral boundary layer solutions** - Integral flow equations
3		**Integral boundary layer solutions** - Pohlhausen method - Thwaites-Walz methods
4		**Integral boundary layer solutions** - Calculation of boundary layer development and laminar separation over subsonic airfoils
5		**Integral boundary layer solutions** - Solution of the integral energy equation for heated plates
6		**Differential boundary layer equations** - Fundamental solutions
7		**Incompressible boundary layer's self-similar solutions** - Blasius solution
8		**Incompressible boundary layer's self-similar solutions** - Falkner-Skan solution **Midterm Exam:** Date TBD
9		**Numerical solutions** - Application of explicit methods to the solution of boundary layer equations (boundary layer with and without pressure gradient)
10		**Compressible boundary layers** - General solutions in supersonic and hypersonic flows
11		**Compressible boundary layers** - Self-similar solution for boundary and thermal layers over a flat plate in supersonic and hypersonic flows
12		**Compressible boundary layers** - Connections between incompressible and compressible boundary layers - the reference temperature method
13		**Compressible boundary layers** - Models for the prediction of boundary layer separation in supersonic flows
14		**Turbulent boundary layers** - Transition, universal law of the wall, roughness effects
15		**Turbulence models** - Eddy viscosity, mixing length
Final Exam	Tursday, May 20, 2021	