

**AE 160 – Aerodynamics I**

<b>Instructor Info</b>	Brian Andrade (408) 964-0513 brianhandrade@gmail.com
<b>Class Days / Time</b>	Monday, Wednesday 0900-1015
<b>Final Exam</b>	December 12 <sup>th</sup> , 0715-0930
<b>Office Hours</b>	Wednesday 1030-1230, Friday 1200-1400, by apt.
<b>Classroom</b>	CLARK HALL 222
<b>Office Hours Room</b>	Engineering 164
<b>Prerequisites</b>	“C” or better in Math32 & Phys50
<b>Co-requisite</b>	Engr100W
<b>Textbook</b>	Instructor Notes, Anderson Fundamentals of Aerodynamics

**Description**

Introduction to incompressible, inviscid and viscous aerodynamics through problem solving, computer simulations, water and wind–tunnel experiments, films, and service learning. Topics include aerodynamic forces and moments, flow classification and similarity, conservation laws with applications in the calculation of lift and drag, and boundary layer theory with emphasis on calculation of skin friction and pressure drag.

<b>Goals</b>	Introduce students to:  A. Modeling of low speed, viscous and inviscid flows. B. Calculation of aerodynamic forces on aerospace and ground vehicles. C. Aerodynamic design for low drag.
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**AE 160 – Aerodynamics I**

D. Water and wind tunnel testing.

**Learning Objectives**

Students completing AE160 should be able to:

1. Explain the nature of aerodynamic forces.
2. Define the aerodynamic center and the center of pressure for an airfoil.
3. Calculate aerodynamic forces and moments on bodies by integrating surface pressure and shear stress distributions.
4. Use flow similarity to design wind tunnel tests.
5. Classify a flow as 1-D, 2-D or 3-D, uniform / non-uniform, viscous / inviscid, compressible / incompressible, steady / unsteady, subsonic, transonic, supersonic or hypersonic.
6. Design and perform flow visualization tests to study the characteristics of the flow around 2-D and 3-D aerodynamic bodies and analyze the results from such experiments.
7. Use the momentum equation to calculate (a) lift from given pressure distributions on the top and bottom of an aerodynamic body and (b) drag from given velocity profiles ahead and downstream of an aerodynamic body.
8. Describe qualitatively and quantitatively laminar and turbulent boundary layers in terms of thickness, velocity profiles, and shear stress variation.
9. Predict transition from laminar to turbulent flow on an aerodynamic surface.
10. Calculate the skin friction drag and estimate the pressure drag of aerodynamic bodies.
11. Predict location on an airfoil surface and inside a nozzle, where boundary layer separation is likely to occur.
12. Design and perform wind tunnel experiments to measure the drag of a 2-D aerodynamic body and analyze the results from such experiments.
13. Design and perform wind tunnel experiments to study boundary layer characteristics on an aerodynamic surface and analyze the results from such experiments.
14. Work effectively in teams to (a) define and solve open-ended aerodynamics problems, (b) design and perform water / wind tunnel experiments, and (c) analyze and present results from such experiments.

## AE 160 – Aerodynamics I

### Course Relationship to BSAE Program Outcomes

	1	2	3	4	5	6	7
<i>Learning Objectives</i>							
1 – 5, 7 – 11	++						
6, 12, 13, 14			+++		+++	+++	+++

+: 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

### Approximate Weekly Schedule

#### Week   Topic(s)

- 01 Introduction to fluids. Density, pressure, viscosity.
- 02 Newton's law of viscosity: calculation of viscous forces.
- 03 Aerodynamic forces and moments.
- 04 Aerodynamic coefficients. Center of pressure. Aerodynamic center.
- 05 Flow similarity. Application in wind tunnel testing.
- 06 Flow description. Streamlines. Flow classification  
**Water tunnel experiment:** Identify flow characteristics, classify flows.
- 07 Continuity. Flow quality. Wind tunnel design.
- 08 Bernoulli. Airspeed measurement. Airfoil pressure distributions.  
**Wind tunnel experiment 1:** Flow quality, calibration of the test section.
- 09 Momentum equation.
- 10 Drag calculation for 2-D bodies.  
**Wind tunnel experiment 2:** Airfoil wake traverses – drag calculations.
- 11 Boundary layers: qualitative description – **Video.**
- 12 Laminar boundary layers: thickness, velocity and shear stress distribution.  
**Wind tunnel experiment 3:** Flat plate boundary layer studies.
- 13 Turbulent boundary layers: thickness, velocity and shear stress distribution.
- 14 Skin friction and pressure drag calculation
- 15 Boundary layer transition and separation – Boundary layer control – **Video.**
- 16 **Project demonstrations**

<b>Grading</b>	Workouts	100 points
	Quizzes	300 points
	Final Exam	200 points
	Project	200 points
	Lab Reports	200 points

950 points < A+

900 points < A

850 points < A-

800 points < B+

750 points < B

700 points < B-

670 points < C+

650 points < C

**AE 160 – Aerodynamics I**

600 points < D  
Below 600 points = F

**Exams**

- You must average **at least 65%** on your tests (quizzes and final) **to receive a passing grade in the course (“C” or “C +”)**. **If you average 65% - 69% on your tests you can only earn a “C” or “C +”** in the course, regardless of the total number of points you may have earned.
- You must average **at least 70%** on your tests (quizzes and final) **to receive an A or a B in the course.**

**Service Learning Project**

You will work in teams – no more than 4 people – to define a **Service Learning Project**. You are encouraged to integrate theory and applications from other courses. Progress reports are due every 2 weeks throughout the semester. You are expected to demonstrate your concept at the end of the semester to elementary school kids at an after school program at the Third Street Community Center in San José (<http://www.3street.org/>) as well as at San Jose High School.

**Laboratory**

You will design and perform in teams - no more than 4 people - 4 experiments in the aerodynamics lab (Engr. 107): one flow visualization experiment in the water tunnel and three experiments in the subsonic wind tunnel. Each experiment takes approximately 2 hours. A lab report is due for each experiment, following the posted guidelines<sup>1</sup>, two weeks after you complete the experiment. **You must earn a minimum of 140 points total in your lab reports to receive a passing grade in the course.**

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<sup>1</sup> < <http://www.engr.sjsu.edu/nikos/courses/Common/Labs/Lab.Report.htm>>