

MAE 108 AEROSPACE LABORATORY

(Required for AE; Elective for ME)

- Catalog Data:** **MAE 108: Aerospace Laboratory (Credit Units: 4) F.** Analytical and experimental investigation in aerodynamics, fluid dynamics, and heat transfer. Emphasis on study of flow over objects and lift and drag on airfoils. Introduction to basic diagnostic techniques. Report writing is emphasized and a design project is required. Prerequisite: MAE130B. (Design units: 2)
- Textbook:** Barlow, J.B., Rae, Jr., W.H. and Pope, A. *Low-Speed Wind Tunnel Testing*, 3rd Edition, John Wiley & Sons, 1999.
LaRue, J.C., Guillaume, D., Petersen, E.L., and Kirkconnell, C. *MAE108 Aerospace Laboratory Manual*, 2004.
- References:** Fox, R.W., McDonald, A.T. and Pritchard, P.J. *Introduction to Fluid Mechanics*, 6th Edition, John Wiley & Sons, 2004.
Bertin, J.J. *Aerodynamics for Engineers*, 4th Edition, Prentice Hall, 2002.
Holman, J.P. *Experimental Methods for Engineers*, 7th Edition, McGraw-Hill, 2001.
- Coordinator:** John C. LaRue
- Course Outcomes:** Students will:
Understand the principals of operation and limitations of sensors and equipment used to experimentally determine the aerodynamic characteristics of objects of interest.
Measure the characteristics of aerodynamic interest on various airfoils.
Determine the effect of airfoil shape on separation of airfoils.
Determine experimental uncertainty.
Develop the skills necessary to report the results of experiments and uncertainty analysis in both written and oral form.
Identify a problem of aerodynamic interest, develop a problem statement, a procedure and experiment to answer questions raised in the design problems statement.
- Prerequisites By Topic:** Fundamentals of Newtonian Mechanics
Calculus and Differential Analysis
Control Volume Analysis
Basic analysis of viscous flows and means whereby aerodynamic forces are generated
- Lecture Topics:** Course overview and discussion of wind tunnel and associated safety issues. Bernoulli equation and potential flow, with emphasis on various pressure contributions (total, dynamic, static). Analysis of Pitot and yaw tubes. Use of associated differential pressure transducers. Viscous flow and boundary layers. Uncertainty analysis and statistical analysis of data. Operation and analysis of force balances. Discussion of sources of drag in simple shapes such as spheres, cylinder, and streamlined objects. Separation and means to control separation. Sources of lift and drag on airfoils, pitching moment, center of pressures, and aerodynamic center. Discussion of separation modes on airfoils. Effect of slats and flaps on lift, drag, and pitching moment. Pressure distribution on airfoils.

Class Schedule: Meets for 3 hours of lecture, 1 hour of discussion, and 3 hours of lab each week for 10 weeks.

Computer Usage: Excel, Word, and LabView.

Laboratory Projects: Use of Pitot and yaw tubes to: (1) determine sensitivity of Pitot tube to misalignment; and (2) determine flow uniformity and flow angle in test section of wind tunnel. Calibration of force transducer, measurement of drag on spheres, cylinders and streamlined shapes. Effect of three dimensional effects on measured drag of 2-D objects. Effect of boundary layer trips on drag. Measurement of lift, drag, and pitching moment on an airfoil. Investigation of separation modes and their effects on drag and lift. Determination of aerodynamic center. Effect of slats and flaps on aerodynamic characteristics. Measurement of pressure distribution on an airfoil. Use of anemometry techniques for characterization of flow over objects and the resulting wake.

Professional Component: Contributes toward the Mechanical Engineering Topics courses and Major design experience.
Contributes toward the Aerospace Engineering Topics courses and Major design experience.

Relationship to Program Outcomes: This course relates to Program Outcomes a, b, c, d, e, g, k, and l; with additional Mechanical Engineering outcome 3 & Aerospace Engineering outcome 1 and 2 as stated at:
<http://undergraduate.eng.uci.edu/degreeprograms/mechanical/mission>
<http://undergraduate.eng.uci.edu/degreeprograms/aerospace/mission>

Design Content Description

Approach: Design exercise chosen from a list provided to the students or can be student initiated. Provide motivation for choice of the design project and perform a literature review. Evaluate potential experimental procedures; justify choice of experimental procedure. Analysis of equipment and/or test apparatus prior to construction or use. Several oral and written progress reports; a final engineering report.

Lectures: 40%

Laboratory Portion: 60%

Grading Criteria:

Laboratory Reports:	40%
Final Project:	25%
Midterm Exam 1:	25%
Midterm Exam 2:	10%
	100%

Estimated ABET Category Content:

Mathematics and Basic Science: ___ credit units or ___ %
Engineering Science: 2 credit units or 50 %
Engineering Design: 2 credit units or 50 %

Prepared by: John C. LaRue (Faculty), Carl Kirkconnell (Lecturer) **Date:** July 2007

CEP Approved: Fall 2004