AAE 33300: Fluid Mechanics

Credit Hours	3
Offered	Fall and Spring
Pre-requisites	AAE 20000 and AAE 20300
Co-requisites	(MA 30300 or MA 30400) and AAE 25100
Instructional Method	3 hours of lecture per week
Required	Yes

1. Course Description

This course is about discovering the secrets of fluid mechanics—encountered in everyday life as well as in every significant human technology—including the secrets of flight. The main goal of this course is to build the framework which will allow us to solve engineering problems involving fluid flow and give the basic understanding needed for further study in this area or to work on interdisciplinary problems involving fluid mechanics.

2. Instructor Information

Prof. Tom I-P. Shih
tomshih@purdue.edu
ARMS 3317

3. Topics Covered

- Introduction: Definition of a fluid. Continuum hypothesis. Aerodynamic variables. Dimensional analysis. Fluid Statics.

- Conservation Equations and Fundamental Principles: Review of vector calculus. Control volumes. Conservation of mass, momentum and energy. Eulerian and Lagrangian frames of reference. Substantial derivative. Streamlines. Vorticity and rate of strain. Circulation. Velocity potential and stream functions.
- Inviscid Incompressible Flow: Bernoulli's equation. Laplace's equation and fundamental solutions for two-dimensional potential flow. Kutta-Joukowski theorem. Kutta condition. Kelvin's circulation theorem. Modeling flows over airfoils.
- Viscous Flow: Viscosity and thermal conductivity. Stress relation for a Newtonian fluid. Navier-Stokes equations. Dynamic similarity. Simple exact solutions. Boundary layer approximation. Blasius' solution. Thwaites' method for laminar boundary layer calculations. Introduction to transition and turbulence

4. Intended Learning Outcomes

On completing this course, the student will be able to:

- Calculate aerodynamic forces and moments from pressure and shear stress distributions.
- Apply dynamic similarity to scale data from experimental conditions to the real problem.
- Apply global conservation of mass, momentum, and energy to engineering problems.
- Apply Bernoulli's equation to make estimates of the flow field.
- Calculate lift for an arbitrary airfoil by using panel methods.
- Calculate drag for an arbitrary airfoil using integral boundary layer methods.

5. Assessment Method

Weekly homework assignments or small projects, two midterm exams and one final exam

6. Relation to ABET Outcomes

	Program Learning Outcomes	Included?
1.	An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.	Yes
2.	An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.	No
3.	An ability to communicate effectively with a range of audiences.	No
4.	An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.	No
5.	An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.	No
6.	An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.	No
7.	An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.	No