ME 4340 Applied Fluid Mechanics (Elective)

Catalog Description: ME 4340 Applied Fluid Mechanics (3-0-3)

Prerequisites: ME 3345 Heat Transfer

Advanced study in fluid mechanics. Topics selected from turbomachinery, flow measurement, compressible flow, aerodynamics, external flows, and microfluidics. Course includes student group projects with oral and written presentations.

Textbook: Bruce R. Munson, Theodore H. Okiishi, Wade W. Huebsch, and Alric P. Rothmayer, *Fundamentals of Fluid Mechanics*, 7th Edition, John Wiley and Sons, 2013.

Topics Covered (not inclusive):

1. A brief refresher on basic fluid mechanics concepts.
2. Introduction to compressible flows, mainly of ideal gases: One-dimensional flow in a converging-diverging duct. Normal shocks. Fanno flows. Rayleigh flows. Oblique shocks.
3. Introduction to turbomachinery: Centrifugal- and axial-flow pumps and turbines, including wind turbines. Velocity triangles. Balance of Angular Momentum. One-dimensional steady energy equation. Euler turbomachine equation. Dimensional analysis. Quantifying efficiency and performance. Interpreting pump curves.
4. Introduction to microfluidics: How are the governing equations for microscale flow different from macroscale flows? An introduction to mass transport. Fick's law and the one-dimensional diffusion equation. Laminar Poiseuille flow at low Reynolds numbers. Taylor-Aris dispersion. A brief review of electrostatics and an introduction to the electric double layer. Electrokinetically driven flows. A brief introduction to microfabrication techniques.

Course Outcomes:

Outcome 1: Improve and expand the student's understanding of the basic principles of fluid mechanics.

1.1 The student will demonstrate the ability to recognize the type of fluid flow that is occurring in a particular physical system, *e.g.* whether a flow is incompressible or compressible, microscale or macroscale, and whether angular momentum is significant in a flow.

1.2 The student will demonstrate the ability, based on their identification of the type of flow, to choose the appropriate fluid mechanical principles needed to analyze these fluid-flow situations.

Outcome 2: Improve and expand the student's skills in analyzing fluid flows through the proper use of modeling and the application of basic fluid-flow principles.

2.1 The student will demonstrate an ability to apply appropriate simplifying assumptions and basic fluid-flow principles to produce a mathematical equation that models the flow in a physical system.

2.2 The student will demonstrate an ability to solve and analyze the mathematical equation associated with a physical fluid-flow system.

Outcome 3: To provide the student with some specific knowledge regarding fluid-flow phenomena observed in mechanical engineering systems, such as flow in turbomachinery, compressible flows in ducts, and flows in capillaries.

3.1 The student will be able to recognize the particular flow regime that is present in a typical engineering system.

3.2 The student will demonstrate knowledge of important practical results in common fluid flows and their physical implications.

Outcome 4: Improve the student's research and communication skills using a self-directed, group study of a contemporary fluid-flow problem with results that will be communicated in both oral and written form.

4.1 The student will demonstrate the ability to research a topic and synthesize information from a variety of sources to analyze and investigate the fluid-flow behavior, and to understand the results.

4.2 The student will demonstrate the ability to work with a group to communicate the results of this detailed fluid-flow study in an oral format.

4.3 The student will demonstrate the ability to work with a group to communicate the results of this detailed fluid-flow study in a written format.

Correlation between Course Outcomes and Student Outcomes:

ME 4340											
	Mechanical Engineering Student Outcomes										
Course Outcomes	a	b	c	d	e	f	g	h	i	j	k
Course Outcome 1.1	X				X						X
Course Outcome 1.2	X				X						X
Course Outcome 2.1	X				X						X
Course Outcome 2.2	X				X						X
Course Outcome 3.1	X				X						X
Course Outcome 3.2	X				X						X
Course Outcome 4.1	X				X				X	X	
Course Outcome 4.2	X				X		X		X	X	
Course Outcome 4.3	X				X		X		X	X	

GWW School of Mechanical Engineering Student Outcomes:

(a) an ability to apply knowledge of mathematics, science and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(d) an ability to function on multidisciplinary teams
(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Prepared by: Minami Yoda