Syllabus
AERO 452 HONORS

Course Title – Heat Transfer and Viscous Flows
Credit Hours – **Credits 3. 3 Lecture Hours.**
Semester – Fall 2017

Instructor Information

Name	Helen L. Reed, Ph.D., P.E.
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Graduate Teaching Assistant Information

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Textbook and/or Resource Material

Text:

Notes by L. Carlson, S. Girimaji, W. Saric, P. Cizmas, H. Reed. ***Available on eCampus as a pdf.***

Other notes. ***Distributed periodically in class and on eCampus.***

Resource material:

F.M. White: *Viscous Fluid Flow, 3rd Edition*, McGraw-Hill, 2006.

H. Schlichting, K. Gersten: *Boundary-Layer Theory, 8th Edition*, Springer, 2000.

T.L. Bergman, A.S. Lavine, D.P. DeWitt, F.P. Incropera: *Introduction to Heat Transfer, 6th Edition*, John Wiley & Sons, Inc., 2011.

F.P. Incropera, D.P. DeWitt: *Fundamentals of Heat and Mass Transfer, 5th Edition*, John Wiley & Sons, Inc., 2007.

Course Description and Prerequisites

Course Description: Navier-Stokes and boundary layer equations; exact and approximate solutions; laminar boundary layers; origin of turbulence; transition; turbulent boundary layers; viscous airfoil design; one and two dimensional heat transfer; methods for steady and transient heat conduction; thermal boundary layers; convection; and radiation.

Prerequisite: Grade of C or better in AERO 351.

Learning Outcomes and Assessment

Learning outcomes:

Upon completion of this course, the student should be able to:

LO-1: Understand and derive fundamental evolution equations governing viscous flow and also derive exact solutions for some relevant flows. Solve basic problems.

LO-2: Perform order of magnitude analysis of Navier-Stokes equations and derive boundary layer equations. Derive Blasius and integral solutions to boundary layer equations. Solve basic problems.

LO-3: Explain fundamentals of instabilities, transition, and turbulence in fluid flow.

LO-4: Understand and apply calculation techniques for 1-D heat transfer.

LO-5: Solve basic problems involving 2-D and transient heat transfer.

Contributions to professional component:

1. Final course in aerodynamics
2. Helps prepare students for engineering practice
3. Builds on foundation established in the core subjects
4. Prepares students for a future in aerodynamics.

Assessment: See end of syllabus

Grading Policies

Class Work:

Students are expected to attend class, and any material missed is the responsibility of the student (see http://student-rules.tamu.edu/rule07).

Course material follows the outline. Students are expected to supplement the lectures with reading from all notes and materials distributed in class and/or available on eCampus.

Students are expected to be aware of material and information distributed via e-mail through *Howdy!*

Homework: Homework is due as assigned. Most of the homework problems are designed to show relevance of the course material with examples taken from the instructor's experience. Late homework is not accepted without either prior arrangement with the instructor or a valid excuse (see http://student-rules.tamu.edu/rule07).

Student Responsibility: Homework will be graded and may be done in a group. What this means is that discussing as a group is fine. But then it is each student's responsibility to work out (including programming where applicable) and write up the work independently from anyone else. Each person's homework will then naturally look different from his/her collaborators. Do not copy the work of others. Copying the work of others is never accepted in the professional environment. Experience teaches that best results occur if the work is done individually. It is not unusual for a homework problem to appear verbatim on an exam. Exams are required to be your own work and covered by the Aggie Honor Code.

http://student-rules.tamu.edu/aggiecode http://aggiehonor.tamu.edu/

Exams: In-class exams will be open notes. You may use a calculator. All other electronic devices (e.g. cell phones/iPhones, blackberries, and so forth) are not allowed to be used during an exam. A make-up exam will only be considered for an excused absence. See:

http://student-rules.tamu.edu/rule07

Grading Scale

Grades will be based on the average of the following:

Quizzes:	5%	
Homework:	20%	Due as scheduled (not late)
Exam 1:	25%	Monday 23 October 2017
Exam 2:	25%	Friday 17 November 2017
Final Exam:	25%	Friday 8 December 2017,1000-1200

Note that the exam ***dates*** are subject to change with advanced notice.

Roughly (as a greatest lower bound): **A**: 90-100; **B**: 80-89; **C**: 70-79; **D**: 60-69; **F**: ≤ 59

Course Topics, Calendar of Activities, Major Assignment Dates

Week	Topic	Required Reading
	Part I Viscous Flows	
1	1. Fundamental concepts and definitions of viscous flow theory	1-13
	a. Fluid friction and Newtonian fluids	
	b. Boundary-layer concepts	
	c. Separation, transition, and turbulence	
1-2	2. Navier-Stokes equations	14-31
	a. Equation of motion and continuity	
	b. Stress-strain concept for fluids	
	c. Navier-Stokes equations	
3-5	3. Exact solutions of Navier-Stokes equations	31-64
	a. Channel and Couette flow	
	b. Hagen-Poiseuille flow (pipe flow)	
	c. Suddenly accelerated plate problem	
5-6	4. Prandtl's boundary-layer equations	65-72
	a. Derivation of equations using order-of-magnitude analysis	
6-7	5. Laminar boundary-layer equations and solutions (flat plate, pressure gradient, …)	72-96
7-9	6. Boundary-layer momentum integral equations	96-110
9-10	7. Boundary-layer stability theory, transition criteria	111-126
10-11	8. Introduction to turbulence and turbulent boundary layers	127-140
	Part II – Heat Transfer	
11	1. Review of 1st and 2nd laws of thermodynamics and introduction of heat transfer	141-154
12-14	2. One-dimensional heat transfer	155-179
	a. Fourier law of conduction and development of heat-conduction equation	
	b. Multi-layered walls	
	c. Use of electrical analogy in complex problems	
	d. Convection at surfaces	
	e. Radial and spherical systems	
	f. Critical radius of insulation	
	g. One-dimensional differential heat-transfer equations	
	h. Conduction with heat source	
	i. Heat transfer from fins	
14	3. Steady-state two-dimensional heat transfer	180-184
	a. Development of the governing differential equations	
	b. Analytical approach	
	c. Numerical approach	
14-15	4. Transient heat conduction	185-196
	a. Analytical approach (lumped heat capacity)	
	b. Numerical approach	
15	5. Convection heat transfer (time permitting)	197-206
	a. Forced convection	
	b. Natural convection	

Americans with Disabilities Act (ADA)

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an

accommodation, please contact Disability Services, currently located in the Disability Services building at the Student Services at White Creek complex on west campus, or call 979-845-1637. For additional information, visit http://disability.tamu.edu.

Academic Integrity

For additional information please visit: http://aggiehonor.tamu.edu

"An Aggie does not lie, cheat, or steal, or tolerate those who do."

Relationship of Course to ABET Student Outcomes

For AERO 452, the following ABET Student Outcomes apply:

3a. Ability to apply knowledge of mathematics, science and engineering

3e. Ability to identify, formulate and solve engineering problems

3k. Ability to use the techniques, skills and modern engineering tools necessary for engineering practice

PC1. Knowledge of Aerodynamics

Learning outcomes (from above)	Assessment method	ABET outcome
LO-1	Homework, exams	3(a), 3(e), PC1
LO-2	Homework, exams	3(a), 3(e), 3(k), PC1
LO-3	Homework, exams	3(a), 3(e), 3(k), PC1
LO-4	Homework, exams	3(a), 3(e), 3(k), PC1
LO-5	Homework, exams	3(a), 3(e), 3(k), PC1