College of Engineering
School of Environmental, Civil, Agricultural, and Mechanical Engineering

MCHE 4500/6500 Advanced Thermal Fluid Systems
Fall 2023

Instructor:

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Topical Outline:

(1) Review of basic thermodynamics, fluid mechanics, and heat transfer;
(2) Introduction to compressible flow;
(3) Normal shock waves;
(4) Oblique shock waves;
(5) Application of compressible flow and shock waves to inlets, nozzles, diffusers of propulsion systems;
(6) Frictionless flow with heat transfer (Rayleigh flow);
(7) Adiabatic flow with friction (Fanno flow);

Description:

The course emphasizes the study and application of advanced concepts in thermodynamics, fluids, and heat and mass transfer beyond initial, introductory courses. This includes application of topics from Thermodynamics (ENGR 3140) and Fluid Mechanics (ENGR 3160) to the analysis of propulsion systems and high-speed aerodynamics, an introduction to compressible flow, shock waves, and non-isentropic flow with friction and heat transfer.

Credit Hours: 3 (lecture)

Prerequisites:

ENGR 3150 – Heat Transfer
ENGR 3160 – Fluid Mechanics

Lecture Times: Tuesday / Thursday, 11:10 A – 12:25 P

Lecture Location: Driftmier Engineering Center, Room 1453

Course Website: eLC

Required Text:

Modern Compressible Flow: With Historical Perspective (4th Edition)
Author: John Anderson
ISBN: 978-1260471441

Elements of Gasdynamics
Authors: Liepmann and Roshko
ISBN: 978-0486419633

Grading*:	Exam 1	20% (topics 1 and 2)
	Exam 2	20% (topics 3 and 4)
	Exam 3	20% (topics 5, 6, and 7)
	Quizzes (3 – 5)	15% (final score assigned from top three scores)
	Final Exam	25% (see **Homework** section below)

*The listed grading scale is for MCHE 4500 (undergraduate level). The overall grade is based on three exams and a homework-based final exam. The course project requirement for MCHE 6500 students (listed below) accounts for 20% of the final grade, and the scale above will be adjusted to include the grade earned. Grading will be relative but, in general, the minimum scale will be based on A = 90 – 100%, B = 80 – 89%, C = 70 – 79%, etc. Pluses and minuses (+ / –) will be given with discretion.

Departmental Grading Policy Regarding Communication Skills: 30% of the grade on all written assignments (e.g. reports, projects, and papers) and oral presentations will be based on quality of communication. Spelling, grammar, punctuation, and clarity of writing are evidence of written communication quality. Enunciation, voice projection, clarity and logical order of the presentation and effective use of visual aids are evidence of oral communication quality.

Homework: Working homework problems is a necessity for practicing and learning the material, and is a tool that leads to developing a deeper understanding beyond the lecture content. Homework will be assigned on an approximately bi-weekly basis (approximately 12 – 15 problems) but will not be collected or graded for a homework grade. Discussion of the solutions to selected problems will take place in lecture, time permitting, or during problem solving sessions. The final exam grade will be based on the grading of one of the homework sets, selected at the end of the term. Diligently working through the assignments and presenting the results in an organized, professional format is strongly encouraged. The grade will be based on the rigor of the methodology applied (i.e. application of assumptions, equations), reaching the correct solution, analysis and interpretation of the result(s), and organizational merits. An important component of the solution is writing comments on the context/meaning of the result.

Academic Honesty: Ethical behavior and academic honesty are expected and required of students and even more so of engineers and scientists. Evidence of cheating during an exam or other assignment for credit may result in failure of the entire course for the student(s) in question. The University of Georgia requires academic honesty and personal integrity among students and other members of the University Community. A policy on academic honesty has been developed to serve these goals. All members of the academic community are responsible for knowing the policy and procedures on academic honesty. The document for academic honesty may be found at the website for The University of Georgia Office of Senior Vice President for Academic Affairs and Provost. All academic work must meet the standards contained in "A Culture of Honesty". Students are responsible for informing themselves about those standards before performing any academic work.

Americans with Disabilities Act (ADA) Policy Statement:
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 Resource Center, in Clark Howell Hall, call 706-542-8719, or email at dsinfo@uga.edu. For additional information visit https://drc.uga.edu/.

Course Objectives and Expected Learning Outcomes: By the end of this course, students will (at a minimum) have achieved the following (a) understand and advanced fundamental principles of thermodynamics and fluid dynamics; (b) understand compressibility effects in gas flows; (c) understand how shock waves are formed, the basic shock wave relationships and their applications; (d) understand and apply mathematical equations governing thermal processes in compressible flow and propulsion applications.

Additional Requirements for Graduate Students (MCHE 6500): In addition to the above requirements for undergraduate students, graduate students must develop one of two projects: (i) a functioning ANSYS model for a simple compressible flow problem that is based on content covered in the course or (ii) a numerical code in Matlab or Python for solving a compressible flow problem. Approval of a brief (< 1 page) summary of the project scope, detailing the approach and solution targets, is required prior to starting the project.

Course Schedule: Table 1 presents the overall course schedule. The planned exam dates are subject to change upon prior notice with at least one week in advance of the exam date.

Table 1. Course schedule: August 16 – December 7, 2023.

Week	*Tuesday*	*Thursday*	*Notes*
1	–	8/17	
2	8/22	8/24	Problem Set 1 Assigned (Thermodynamics)
3	8/29	8/31	Problem Set 2a Assigned (Compressible Flow)
4	9/5	9/7	
5	9/12	9/14	Problem-Solving Session/Monday; ***Exam 1 on 9/14***
6	9/19	9/21	Problem Set 2b Assigned (Compressible Flow)
7	9/26	9/28	
8	10/3	10/5	
9	10/10	10/12	Problem-Solving Session; ***Exam 2 on 10/12***
10	10/17	10/19	Problem Set 3 Assigned (Shock Waves)
11	10/24	10/26	
12	10/31	11/2	
13	11/7	11/9	Problem Set 4 Assigned (Fanno Flow)
14	11/14	11/16	Problem Set 5 Assigned (Rayleigh Flow)
15	11/21	11/23 (no class)	Thanksgiving / Tofurky Day
16	11/28	11/30	Problem-Solving Session
17	12/5	–	submit all Problem Sets on 12/5; ***Exam 3 on 12/7, 12 P***