SYLLABUS
SPRING 2021/22

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AE 306 AERODYNAMICS II (COMPRESSIBLE AERO.)

Instructor: Asst. Prof. Dr. Emre Kara (Room Z04)

Lecture Assistant: Res. Asst. Burak Çiftçioğlu

Lecture Hours: 08:30 – 11:05 Thursday - A11

Course Webpage: http://www1.gantep.edu.tr/~emrekara/index.php/ae306/

Course Objectives
To define compressibility and its effects on fundamental flow equations.
To teach students shock and expansion waves and related calculation methods.
To teach students linearization of fundamental equations and the conditions under which they apply.
To furnish the students with the ability to calculate the flow field and aerodynamic forces in compressible flow.

Lecture notes
AE306 lecture notes will be a compound of

- "Compressible Flow" lecture notes of Javier Urzay (from Center for Turbulence Research, Stanford University)
- "Fundamentals of Aerodynamics" textbook and
- "Modern Compressible Flow: With Historical Perspective" textbook.

Textbooks

- "Fundamentals of Aerodynamics", J.D. Anderson, McGraw-Hill, 2001 or newer.
- "Modern Compressible Flow: With Historical Perspective", Third Edition, J.D. Anderson, McGraw-Hill, 2003.

Supplementary Textbooks

- "Gas Dynamics", M.H. Aksel and O.C. Eralp, Prentice-Hall, 1993.
- "Aerodynamics for Engineering Students", Fifth Edition, E.L. Houghton and P.W. Carpenter, Butterworth-Heinemann, 2003.
- "Aerodynamics for Engineers", Fifth Edition, J.J. Bertin and M.L. Smith, Prentice-Hall, 2008.
- "Compressible Flow", M.A. Saad, Prentice Hall, 1993.
- "The Dynamics and Thermodynamics of Compressible Fluid Flow", A.H. Shapiro, Wiley, 1953.

Prerequisites
AE 305
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TENTATIVE SCHEDULE (Lecture notes will be followed as the primary source for the exams. Small changes can be made in the order and/or dates of the chapters for time considerations.)

Week 1 (Feb 24th)	Introduction
Week 2 (Mar 3rd)	***Chapter 1: Compressible Flow: Fundamental Aspects*** 1.1 Conservation Equations (Review on Thermodynamics and Fluid Mechanics)
Week 3 (Mar 10th)	1.2 Speed of Sound and Mach Angle 1.3 Isentropic Flows 1.4 Bernoulli Equation for Compressible Flows 1.5 Compressibility 1.6 Stagnation and Static Quantities 1.7 Ideal Motion of Gases in Variable-Area Ducts 1.8 Effects of Variable Area in Subsonic and Supersonic Flows
Week 4 (Mar 17th)	***Chapter 2: Shocks (Normal and Oblique) and Expansion Waves*** 2.1 Surfaces of Discontinuity 2.2 Shock Waves 2.3 Weak Shocks
Week 5 (Mar 24th)	2.4 Prandtl-Meyer Expansion Fans 2.5 Supersonic Wave Drag and Compression Lift 2.6 Reacting Normal Discontinuities 2.7 Interactions of Shock Waves with Walls 2.8 Internal Structure of Shock Waves and Non-Equilibrium Processes HW1 will be given at the end of the lecture. It will be collected by the lecture assistant at the beginning of the next week's problem solving session.
Week 6 (Mar 31th)	Problem Solving Session for MT1 (3 hours)
Week 7 (Apr 7th)	**MIDTERM 1 Apr 7th, 2022: 08:30 – A11**
Week 8 (Apr 14th)	***Chapter 3: Compressible Flows in Ducts and Nozzles*** 3.1 Dynamics of Convergent-Divergent Nozzles 3.2 Rocket Engine Nozzles 3.3 a. Flows in Ducts with Heat Addition
Week 9 (Apr 21th)	3.3 b. Flows in Ducts with Friction ***Chapter 4: Wave Motion in Compressible Flows*** 4.1 Moving Normal Shock Waves
Week 10 (Apr 28th)	4.2 Reflected Shock Wave 4.3 Physical Picture of Wave Propagation 4.4 Elements of Acoustic Theory 4.5 Finite (Nonlinear) Waves HW2 will be given at the end of the lecture. It will be collected by the lecture assistant at the beginning of MT2.
Week 11 (May 5th)	4.5 Finite (Nonlinear) Waves (Continues) 4.6 Incident and Reflected Expansion Waves 4.7 Shock Tube Relations Problem Solving Session for MT2 (2 hours)
Week 12 (May 12th)	**MIDTERM 2 May 12th, 2022: 08:30 – A11**

Week 13 (May 19th) **19 Mayıs Atatürk'ü Anma, Gençlik ve Spor Bayramı - HOLIDAY**

Week 14 (May 26th) ***Chapter 5: Two Dimensional (Linearized) Compressible Flows***
5.1 Irrotational Flow
5.2 The Velocity-Potential Equation
5.3 Small Perturbation Theory
5.4 Linearized Velocity Potential Equation
5.5 Linearized Pressure Coefficient
5.6 Linearized Subsonic Flow
5.7 Improved Compressibility Corrections
5.8 Linearized Supersonic Flow
5.9 Critical Mach number
HW3 will be given at the end of the lecture. IT WILL BE SUBMITTED TO LECTURE ASSISTANT IN HIS OFFICE, ONE WEEK LATER.

FINAL EXAM: June 9th, 2022 Thursday **15.20**. Classes A11 and A12.

Exams

There will be two midterms and one final examination. **You must bring one A4 page (both sides of the page can be filled) of formula sheet (HANDWRITTEN BY YOUR OWN) for each midterm exam. You can bring two A4 pages of formula sheet to the final. Necessary tables will be supplied on the lecture site; each student should bring his/her own copy of this AERODYNAMICS TABLE to each exam.**

Course Grade

The grading will be based on a weighting of **15** % on the homeworks, **20** % on the midterm-1, **25** % on the midterm-2, and **40** % on the final exam.

Performance is assessed based on
1. The skill to solve given problems
2. Clarity of the motivation of the steps involved in solving a problem
3. Clarity of the presentation of the results.

Each of these three points carries equal weight.

Policies:

- Regular and punctual attendance (at least 70%) and participation are expected.
- Computers and cell phones must be turned off during lectures, no texting, chatting etc.
- Absence from tests must be explained with medical certificates or other valid reasons beyond your control and planning.
- Ask anyone for help on homework, but what you submit must be your own work.