ASTE 301b: Astronautical Gas Dynamics

(Catalog Title: Thermal and Statistical Systems)

Spring 2021

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Course Description

This course has been revised from the previous ASTE301b Thermal and Statistical System. This course combines materials from typical introduction level compressible gas dynamics with that from introduction level gas kinetics and rarefied gas dynamics to present a comprehensive study of the gas kinetics, gas dynamics, and rarefied gas dynamics relevant to astronautical engineering.

Text

Course notes. To be posted in pdf format on blackboard

Additional reference texts (optional):

P. Hill and C. Peterson, *Mechanics and Thermodynamics of Propulsion*, 1978, Addison Wesley

D. Erwin and J. Kunc, ASTE301AB lecture notes.

Recommended Readings:

J. Bond, K. Watson, J. Welch, *Atomic Theory of Gas Dynamics,* 1965, Addison-Wesley

G. Bird, *Molecular Gas Dynamics and the Direct Simulation of Gas Flows*, Clarendon Press

H. Liepmann and A. Roshko, Elements of Gas Dynamics, 1957, Wiley

Expectations

Honor Code: students are expected to follow the university honor code. You are encouraged to discuss homework assignments with your instructor, teaching assistant, and classmates. However, all work submitted for a grade must reflect your own understanding of the material. You may not copy answers to homework problems and you may not assist others or seek assistance on exams.

Homework Policy: There will be homework assignments approximately once per week. Homework must be turned in to me at the beginning of the lecture hour on the due date. *Late homework will not normally be accepted.*

Grading

Homework	33%
Mid-Term Exam	33%
Final Exam	34%

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Week	Subject
1 1/19, 1/21	Course introduction and overview Collisional vs. collisionless. Review of basic gas kinetics and thermodynamics concept
2 1/26, 1/28	Description of continuum flow. Fluid dynamics concepts. Governing fluid equations. Applications of the integral form of fluid eqs.
3 2/2, 2/4	Applications of the integral form of fluid eqs. 1-D continuum flow of a perfect gas Isentropic flow in a nozzle
4 2/9, 2/11	Non-isentropic flow: Flow with heating and friction, Shocks
5 2/16, 2/18	Ideal rocket; Rocket propulsion applications
6 2/23, 2/25	2-D continnum flow of a perfect gas Supersonic vs. subsonic gas flow; Expansion of supersonic gas flow
7 3/2,3/4	Expansion waves; Shocks Supersonic gas flow around objects; Thin airfoils
8 3/9	Review
8 3/11	**Mid-Term Exam (March 11th)**
9 3/16, 3/18	Rarefied flow vs. continuum flow. Description of rarefied flow. Phase space; Distribution functions; Kinetic equations
10 3/25	From kinetic equations to fluid equations Calculations of moments
11 3/30, 4/1	Rarefied gas flow; Rarefied gas-surface interactions Surface accommodations; Spacecraft drag calculation
12 4/6, 4/8	Collisions in gas. Basic collision calculations
13 4/13, 4/15	Basic transport calculations Thermodynamic equilibrium state vs. non-equilibrium state
14 4/20	Intro. statistical thermodynamics
15 4/27, 4/29	Intro. ionized gases and plasmas Review
	Final Exam (during exams week)

(Schedule subjected to change)