

AE 6050: Outline

This is a *tentative* outline of the material that will be covered and the appropriate chapter assignments from Vincenti and Kruger (plus optional parallel readings from Anderson). Class lectures will parallel and *expand upon* the coverage in the text.

	Reading V&K (Anderson)	~#Lectures
I. Introduction and Review		3
A. Ideal vs. High Temperature Gas Dynamics	(Ch. 9)	
B. Ideal Gas Dynamics Review	any undergrad. text	
C. Kinetic Theory Review	I.1-4,6; II.1-6 (Ch. 12)	
1. Pressure and Temperature		
2. Maxwellian Velocity Distribution		
3. (Bimolecular) Collision Rates		
D. Statistical Mechanics Review	IV.1-12 (11.1-8)	
1. Boltzmann's Relation and Boltzmann Distribution		
2. Thermodynamic Properties From Partition Functions		
3. Partition Functions and Energy Modes		
4. State Relations/Specific Heats		
II. Equilibrium Properties of (Reacting) Gas Mixtures	IV.13; V.1-6 (11.9-14)	2
A. Law of Mass Action (from Statistical Mechanics)		
B. High Temperature Air (plots)		
C. Ideal Dissociating Gas		
D. Ionization Equilibrium (Saha Equation)		
III. Equilibrium and Frozen Flows	VI.1-3,5; VIII.5 (14.3-5,7)	3.5
A. Steady Shocks		
1. Equilibrium Normal Shocks		
a. Equations		
b. Shock Temperature Ratio		
c. Shock Density Ratio		
d. Shock Pressure Ratio		
e. Other Effects		
f. Example – High altitude air (plots)		
2. Equilibrium Oblique Shocks (plots)		
3. Frozen Flow and Shocks		
B. Steady Nozzle Flow		
1. Equations and Throat Condition		
2. Solutions		
3. Examples		
C. Prandtl-Meyer Flow		
D. Equilibrium Speed of Sound (plots)		
E. Collision and Flow Times		

IV. Nonequilibrium Processes	VII.1-4,6-8(Ch. 13)	3.5
A. Vibrational Nonequilibrium		
1. V-T Rate Equations for Harmonic Oscillator		
2. Relaxation Time Constant (Landau-Teller, Millikan and White)		
3. V-V Effects		
B. Entropy Production by Vibrational Nonequilibrium		
C. Chemical Nonequilibrium		
1. Reaction Mechanisms and Rate Equations (Air Mechanism)		
2. Rate Constants (Modified Arrhenius form)		
D. Entropy Production by Chemical Nonequilibrium		
V. Inviscid Nonequilibrium Flows	VIII.1-3,9,13,15,16(15.1-5)	2
A. Equations (Inviscid)		
B. Normal Shocks		
C. Oblique Shocks (Flow over Concave Walls)		
D. Prandtl-Meyer Expansion (Flow over Convex Walls)		
E. Nozzle Flow		
F. Blunt Body Flow		
VI. Translational Nonequilibrium–Nonequilibrium Kinetic Theory	IX.1-5	3
A. Continuum (Classical) Gas Dynamics – Navier Stokes Equations		
B. Molecular Conservation Equations		
C. Molecular Interpretation of Transport Terms		
D. The Boltzmann Equation		
E. Equilibrium Velocity Distribution and Molecular Transport Terms		
F. Small Departures from Equilibrium: Chapman-Enskog Solution		
VII. Radiative Energy Transfer in Gases	XI.1-7(18.1-2)	2
A. Radiation Equations		
1. Radiative Flux Vector and Intensity		
2. Radiative Equilibrium – Blackbody Radiation		
3. Equation of Radiative Transfer (and Optically Thin and Thick Limits)		
B. Radiative Properties of Gases		
1. Molecular Parameters – Einstein Coefficients		
2. Relationship to Absorption Coefficient		
C. Molecular Spectra		
1. Line Broadening		
2. Multiple Transitions and Molecular Bands		
D. Flows with Radiation		