

AE 6050 Gas Dynamics

Catalog Description: AE 6050: Gas Dynamics. 3-0-3

Defining equations for compressible flows, real gas properties and their effect on the behavior of equilibrium and non-equilibrium flows.

Coordinator: Dr. Stephen M. Ruffin, Professor

Text at the level of:

Hypersonic and High Temperature Gas Dynamics, J. D. Anderson, McGraw-Hill Inc., 1989; and
Introduction to Physical Gas Dynamics, Walter Vincenti and Charles Kruger, Jr., Krieger, 1965.

Learning Objectives:

1. Basic equations of motion for compressible flows.
2. Equilibrium properties of high temperature gases, e.g., calorically imperfect gases and reacting gases.
3. Real gas effects for equilibrium and frozen flows.
4. Rates of nonequilibrium processes and the behavior of nonequilibrium flows.

Prerequisites:

1. Exposure to undergraduate level compressible (ideal gas) flow, normal and oblique shocks, 1-D nozzle flow and Prandtl-Meyer expansions.
2. AE 6765 or equivalent.

Introduction and Review

- Continuity Equation, Momentum Equations, Energy Equation, Entropy Equation, Kinetic Theory
- Statistical Mechanics

Equations of State: Equilibrium Properties of (Reacting Gas Mixtures)

- Law of Mass Action
- High Temperature Air
- Ideal Dissociating Gas
- Ionization Equilibrium (Saha Equation)

Equilibrium and Frozen Flows

- Normal Shocks
- Steady Nozzle Flow
- Frozen Flow
- Equilibrium Speed of Sound

Nonequilibrium Processes and Properties

- Vibrational Nonequilibrium
- Entropy Production by Vibrational Nonequilibrium
- Chemical Nonequilibrium
- Entropy Production by Chemical Nonequilibrium
- Generalized Rate Equation (and Local Equilibrium)

Nonequilibrium Flows

- Governing Equations
- Normal Shocks
- Oblique Shocks (Flow over Concave Walls)
- Prandtl Meyer Expansion (Flow over Convex Walls)
- Blunt Body Flow
- Nozzle Flow

Translational Nonequilibrium

- Nonequilibrium Kinetic Theory
- The Boltzmann Equation and its Moments
- Flows with Translation Nonequilibrium

Radiative Energy Transfer in Gases

- Radiation from a Blackbody
- Radiation in Absorbing, Emitting and Scattering Media
- Radiative Properties of Gases
- Equation of Radiative Transfer and Approximate Solutions
- Flows with Radiative Nonequilibrium