



Ferdowsi University of Mashhad
Department of
Mechanical Engineering

Gas Dynamics Syllabus

Instructor: Ehsan Roohi
PhD, Assistant Professor

Textbooks:

- Anderson, J.D., “*Modern Compressible Flow With Historical Perspective*, Mc Graw Hill, 2nd edition, 2003.

Highly recommended references:

- Lipmann, H.W., Roshko, A., *Elements of gas dynamics*, John Wiley & Sons Inc. (1957), Dover Publications (2002).
- Thompson, P. A., *Compressible fluid dynamics*, Mc Graw Hill, 1972.

Lecture Notes:

- Available in the copy center of the Department.

Contents:

Chapter 1: **Review of preliminary concepts**

- 1- Ideal Gas
- 2- Reversible and irreversible process
- 3- First and second laws of thermodynamics
- 4- Integral equations for quasi one dimensional flows, isentropic relations
- 5- One dimensional flows, normal shock relations
- 6- Area velocity relation, flow inside nozzles and diffusers
- 7- Fanno flow
- 8- Rayleigh flow

Chapter 2: **Supersonic steady 1-D flow**

- 1- Oblique shock relations, shock polar diagram
- 2- Isentropic compression and expansion
- 3- Characteristics theory, Riemann invariants for steady flows

- 4- Wave interactions
- 5- Thin supersonic airfoil theory

Chapter 3: **Unsteady 1-D flow**

- 1- Review of shock relations, isentropic relations
- 2- Moving normal shock
- 3- Differential equations for unsteady 1-D flows
- 4- Small perturbation approximation, Wave equation
- 5- Characteristics, Riemann invariants
- 6- Waves interactions

Chapter 4: **Governing equations for inviscid flow**

- 1- Review on vector analysis
- 2- Basic differential equations
- 3- Crocco theorem, vorticity, Bernoulli equation (general form),
- 4- Second order ODE for velocity potential, elliptic and hyperbolic equations
- 5- Natural coordinates

Chapter 5: **Small Perturbation theory**

- 1- Linear differential equations and boundary conditions
- 2- 2-D supersonic flow, wavy wall solution, Prandtl-Glaert similarity
- 3- Small perturbation theory for lift and drag coefficients

Score Policy:

HW (6-8 sets): 20%

Midterm: 40%

Final: 40%

HW's should be submitted according to the official format.

Exam:

Mid-term Date: 31-01-1392

Final: According to official schedule