Ferdowsi University of Mashhad
Department of Mechanical Engineering

Gas Dynamics II
Syllabus

Instructor: Ehsan Roohi
PhD, Assistant Professor

http://e.roohi.profcms.um.ac.ir/index.php/interests-and-research/8089

Textbooks:

- Anderson, J.D., "**Modern Compressible Flow with Historical Perspective**, Mc Graw Hill, 2nd edition, 2003.
- روحی، احسان، دینامیک گازها، در دست انتشار (فایل الکترونیکی)
- **Microfluid Mechanics,** W. W. Liou and Y. Fang, McGraw-Hill, New York, 2005.
- Lecture notes of Prof. J B Young on "**Molecular Thermodynamics**", Cambridge University Press.
- **The DSMC Method**, G.A. Bird, CreateSapce Publisher, 1st edition, 2013, ISBN/ EAN13: 1492112909/9781492112907.

Contents:

- Chapter 1: **Governing Equations, Shock Waves, Unsteady 1-D flow** (MCF, Roohi)

  Governing equations, speed of sound
  Review of shock relations, Rankine-Hugoniot and Rayleigh relations for shock waves
  Shock Interaction: Regular vs. Irregular reflections, Hysteresis Phenomenon
  Moving normal shock
  Small perturbation approximation, Wave equation, Riemann invariants
  Unsteady waves interactions

- Chapter 2: **Basics kinetic theory**

  Molecular Model
  Micro and Macroscopic Properties
  Binary Collisions
  Kinematics
  Dynamics and post-collision properties

Molecular force field models
Statistical Gas Properties
Position and Velocity Distribution Functions
Boltzmann Equation and Maxwellian Distribution Function

- Chapter 3: **Moment Method: Navier-Stokes and Burnett Equations**

Introduction
Moment Equations
The Chapman-Enskog Expansion
The Krook equation
The Boltzmann equation
Closure Models
First-order modeling
Second-order modeling

Chapter 4: **DSMC Procedure and Algorithms**

Conventional DSMC
Overview
Methodology
Binary elastic collisions
Collision sampling techniques
Cell schemes
Sampling of macroscopic properties
DSMC Accuracy and Approximation
Relationship between DSMC and Boltzmann equation
Computational approximations and input data
Pressure boundary conditions in DSMC
Gas surface interaction models
Wall slip models in continuum models

Score Policy:

Written HW's: 10%
Mid Term: 25%
Computer HW's: 35%
Final: 30%