Advanced Gas Dynamics Course Description

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Chapter I: Introduction
1.1 Brief History

Chapter II: Review of Elementary Principles
2.1 Introduction
2.2 Units and Notation
2.3 Some Mathematical Concepts
2.4 Thermodynamic Concepts for Control Mass Analysis

Chapter III: Fundamentals of Basic Fluid Mechanics
3.1 Flow Dimensionality and Average Velocity
3.2 Transformation of a Material Derivative to a Control Volume Approach
3.4 Conservation of Mass
3.5 Conservation of Momentum
3.6 Conservation of Energy

Chapter IV: Introduction to Compressible Flow
4.1 Sonic Velocity and Mach Number
4.2 Wave Propagation
4.3 Equations for Perfect Gases in Terms of Mach Number
4.4 h–s and T –s Diagrams

Chapter V: Isentropic Flow
5.1 Stagnation State for Ideal Gas Model
5.2 Isentropic Flow Examples
5.3 Isentropic Converging-Diverging Flow in Cross Section
5.4 The Properties in the Adiabatic Nozzle
5.5 Isentropic Tables
5.6 The effects of Real Gases

Chapter VI: Standing Normal Shocks
6.1 Introduction
6.2 Governing Equations
6.3 Shock Analysis—General Fluid

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6.4 Working Equations for Perfect Gases
6.5 Normal-Shock Table
6.6 Shock Thickness
6.7 Shock or Wave Drag
6.8 Shocks in Nozzles

Chapter VII: The Moving Shocks

7.1 Normal Velocity Superposition: Moving Normal Shocks
7.2 Shock or Wave Drag Result from a Moving Shock
7.3 Shock Result from a Sudden and Complete Stop
7.4 Moving Shock into Stationary Medium (Suddenly Open Valve)
7.5 Partially Open Valve
7.6 Partially Closed Valve
7.7 Shock Tube
7.8 Shock with Real Gases

Chapter VIII: Oblique Shock

8.1 Introduction to Oblique Shock
8.2 Introduction to Prandtl–Meyer Function
8.3 Introduction to Zero Inclination
8.4 Solution of Mach Angle
8.5 Tangential Velocity Superposition: Oblique Shocks
8.6 Oblique-Shock Analysis: Perfect Gas
8.7 Oblique-Shock Table and Charts
8.8 Detached Shock
8.9 Issues Related to the Maximum Deflection Angle
8.10 Regular Reflection from a Solid Boundary

Chapter IX: Prandtl‑Meyer Flow

9.1 Argument for Isentropic Turning Flow
9.2 Prandtl–Meyer Function
9.3 Analysis of Prandtl–Meyer Flow
9.4 Over Expanded and Under Expanded Nozzles

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9.5 Supersonic Airfoils

Chapter X: Fanno Flow
10.1 Analysis for a General Fluid
10.2 Working Equations for Perfect Gases
10.3 Reference State and Fanno Table
10.4 Friction Choking
10.5 Supersonic Branch
10.6 Maximum Length for the Supersonic Flow
10.7 Practical Examples for Subsonic Flow
10.8 Adiabatic Flow with Friction in a Variable-Area Duct

Chapter XI: Rayleigh Flow
11.1 Introduction
11.2 Governing Equation
11.3 Reference State and the Rayleigh Table
11.4 Correlation with Shocks
11.5 Thermal Choking due to Heating

Chapter XII: Linearized Flow
12.1 Linearized Potential Flow
12.2 Pressure Coefficient
12.3 Subsonic Flow Over a Wavy Wall
12.4 Similarity Laws for Subsonic Flow
12.5 Prandtl-Glauert Rules
12.6 Linearized Supersonic Flow
12.7 Airfoils in Supersonic Flow
12.8 Two Dimensional Airfoils

Chapter XIII: Method of Characteristics
13.1 Introduction
13.2 Equation of Characteristic's For Two-Dimensional Flow
13.3 Characteristic's Curves in the Hodograph Plane
13.4 Numerical Computation

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13.5 Flow over a Curved Wall
13.6 Design of Supersonic Nozzles
13.7 Intersection of Characteristics with a shock Wave

Grading: The Following Weights Will Be Used For Grading:

Homeworks and Projects	20%
Midterm Exam	30%
Final Exam	50%
Total	100%

List of References:

- Anderson J. D., ”Fundamental of Aerodynamic’s," 5th edition, McGraw-Hill, 2009.
- Zucker R. D, Biblarz J. D., ”Fundamental of Gas Dynamic’s,"2nd edition, John-Wiley, 2002.
- John J. E., Keith T. H., “Gas Dynamics”, 3rd edition, Prentice-Hall Inc., 2006.
- Anderson J. D., “Modern Compressible Flow”, 3rd edition, McGraw-Hill, 2003.