

ME 419 Course Contents

Review of Fluid Mechanics and Thermodynamics

- Difference between the Euler's and Bernoulli's equations.
- What is compressibility.
- Difference between the compressibility of fluid and the compressibility of flow.
- Role of Mach number in characterizing flow compressibility.
- Ideal gas and Calorically perfect gas.
- First and Second laws of thermodynamics.
- Internal energy, entropy, specific heats, state variables.
- Isothermal, adiabatic and isentropic processes.
- System and control volume, Reynolds Transport theorem
- Continuity, momentum, and energy equations in the integral form.

Wave Phenomena (Chapter 2:Textbook)

- Wave propagation, speed of sound, weak (isentropic) compression and expansion waves.
- Mach cone, zone of silence, zone of action.

Isentropic Flow in a Variable-Area Channel (Chapter 3)

- Inviscid, Compressible Flow: continuity, momentum, and energy equations in the differential form.
- Effect of area change on flow properties for subsonic and supersonic flows
- Stagnation temperature and pressure, Relation between channel area and Mach number.
- Isentropic flow equations and tables.
- Isentropic flow in a converging nozzle, effect of back pressure, choked flow.
- Isentropic flow in a converging-diverging nozzle:
- Effect of back pressure, choked flow.
- Subsonic solution, supersonic solution
- Underexpanded flow (normal or oblique shocks)
- Overexpanded flow.

Normal Shock Waves (Chapters 4-5)

- Creation of a normal shock
- Normal shock equations and Tables
- Change of entropy and stagnation pressure across a normal shock
- Location of normal shock in a converging-diverging nozzle.
- Moving normal shock
- Reflection of a normal shock at a closed end and at an open end.

- Converging-diverging diffuser
- Shock tube

Oblique Shock Waves (Chapter 6)

- Equations for an oblique shock
- Oblique shock tables, strong and weak oblique shocks
- Detached shock, Oblique shock reflections

Prandtl Meyer Flow (Chapters 7 and 8)

- Weak compression and expansion waves.
- Equations for a Prandtl Meyer Fan
- Fan Angle
- Reflection of a expansion fan at a solid boundary, and at an open boundary
- Supersonic airfoils, lift and drag coefficient

Flow with Friction (Chapter 9)

- Fanno line flow
- Flow through a constant-area duct, Choking
- Relation between friction factor and Mach number
- Effect of friction on properties in subsonic and supersonic flow
- Flow through a converging nozzle and constant-area duct
- Flow through a converging-diverging nozzle and constant-area duct
- Isothermal flow through a constant-area duct

Flow with Heat Transfer (Chapter 10)

- Rayleigh-line flow, constant-area frictionless flow with heat addition
- Normal shock on Rayleigh and Fanno line-T-s diagram
- Effect of heating on flow properties in subsonic and supersonic flow
- Flow with friction and heat transfer