MECH 434: Compressible Flow

Catalog description: 3.0 units

Compressible fluids in isentropic flow, normal and oblique shock, Prandtl-Meyer expansion, Fanno, and Rayleigh flow. Subsonic and supersonic flow, with applications to rocket and jet propulsion, wind tunnels, shock tubes, airfoils, and combustion chambers.

Prerequisites: CIVL 321, MATH 260, MECH 332
Recommended: MECH 306

Course objectives: For students to

1. Learn the concepts needed to analyze non-chemically reacting continuum compressible gas flows
2. Apply these concepts to estimate flow properties for nozzles, diffusers, shock tubes, gas pipelines, supersonic wind tunnels, and flow around supersonic airfoils

Course outcomes: Students shall be able to

1. Compute static and stagnation pressures and temperatures, Mach number and gas density variations across normal and oblique shocks; expansion fans
2. Compute Mach number, pressure, and temperature variations and mass flow rates through nozzles and diffusers

Topics covered

1. Definition of compressible flow, flow regimes, brief review of thermodynamics, conservation equations for inviscid flows
2. One-dimensional flow equations, speed of sound and Mach number, normal shock relations
3. Quasi-one-dimensional flow equations, area-velocity relation, nozzles and diffusers
4. Oblique shock relations, supersonic flow over wedges and cones, shock reflections. Prandtl-Meyer expansion waves
5. One-dimensional flow with friction (Fanno flow), one-dimensional flow with heat transfer (Rayleigh flow)

Class/Laboratory schedule

One hundred fifty minutes of lecture per week

Contribution of course to meet the professional component

This course contributes to the student's ability to work professionally in the thermal systems area.

Relationship of course to Mechanical Engineering Program Outcomes

This course contributes principally to Program Outcome A.