2.25
Fall 2004 Ain A. Sonin, Gareth H. McKinley, MIT

5   Control Volume Theorems

5.1   The Reynolds transformation, which allows the laws for material volumes to be re-expressed in terms of an arbitrarily specified *control volume* (an open system with an arbitrarily specified boundary).

5.2   Physical laws expressed in terms of (1) a material particle, (2) a material volume, and (3) a control volume: mass conservation, equation of motion, first law of thermodynamics, second law of thermodynamics.

5.3   The mass conservation law in control volume form. Examples involving various control volume choices for a given problem.

5.4   The linear momentum equation (Newton's law of motion in control volume form). Various examples, steady and unsteady, including a fuel-laden space rocket accelerating to speed, transient flows involving phase change, jet engines, propellers and windmills, determining drag from wake profiles, etc.

5.5   The angular momentum theorem (a moment of Newton's law, expressed in control volume form). Various examples, ranging from lawn sprinklers and centrifugal pumps to the transient spin-up of bathtub vortices and tornadoes.

5.6   Control volume forms of the energy equation (first law of thermodynamics) and the second law of thermodynamics. Examples.

Read:

Fay: Chapter 5
Kundu & Cohen   Chapter 4.1 – 4.9, 4.14 – 4.15

Sonin: handouts and on MIT server:

"Fundamental Laws of Motion for Particles, Material Volumes, and Control Volumes."

"On Choosing and Using Control Volumes: A Simple Example."

Problems:

Posted *on Web only* (numbers are *not same* as in Advanced Fluid Dynamics Problems book): 5.02, 5.03, 5.08, 5.10, 5.11, 5.15, 5.17, 5.19, 5.24, 5.26, 5.27, 5.28, 5.29. Full solutions are provided for Problems 5.19 (linear momentum) and 5.24 (angular momentum); for the others, there are answers and hints.