Assignment #8 : Compressible Flow Basics — ME 412

due 11/2/2016 before midnight via Learning Suite — 50 possible points

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It is not explicitly mentioned in these textbook problems, but in all cases you should assume an ideal gas.

8.1 Munson 11.30. Assume the length scale is fixed. In other words, you can change any fluid properties, but can't change the geometry. This is a common scenario in CFD because that allows you to avoid remeshing. Don't use vague descriptions: if you wanted to double the Mach number, explicitly describe what parameters you would change and by what factor. (Note: this is related to the reason why some of you who used a scaled geometry for the backwards facing step saw discrepancies in your solutions.)

8.2 Munson 11.37. For the incompressible case, I don't think it makes sense to compute the Mach number, just compute the velocity. Technically, the incompressibility assumption implies that the speed of sound is infinite and the Mach number is zero. But do be sure to compute the Mach number for the compressible case. Don't use table values for anything (except γ and R), compute any quantities that are needed.

8.3 Munson 11.40. Complete all parts except for the last two parts (i.e., don't worry about the temperature-entropy diagram and don't worry about the over- and underexpanded cases). This problem is best solved with a computer. Clearly label subsonic vs supersonic branches. Even though you won't address the over- and underexpanded cases, you should view the video referred to here: Video 11.7

8.4 **Open-Ended:** Imagine a meteor the size of a house striking the Earth (this is quite large, but no where near the estimated size of the meteorite the formed the Chicxulub crater). Estimate the Mach number just before impact, and the damage of the impact for two different scenarios that you describe. You should do at least one typical meteorite scenario, but others could be more outlandish (e.g., taking a meteor up on your supership and dropping it from 60,000 feet, strapping a bunch of rockets to the meteor to accelerate it, etc.). Be descriptive as to what might happen to the meteorite and to the Earth. Depending on what you assume, the physics involved can quickly go beyond the scope of this class. We aren't worried about high accuracy here. The purpose is to continue to develop open-ended problem solving skills and to develop an understanding of the relevant concepts across a broader scale.

8.5 **CFD (Extra Credit):** This week we will take a break this week from running any CFD, but will instead learn from a couple of video tutorials: one on creating a parameterized CAD description of a transonic wing, and another on best practices for transonic/supersonic wing simulation. Briefly report on what you learned.