Aerodynamics II (AE-612) (2019-20 – I Semester)

Assignment 2

Due Date: 10/9/19

(Unsteady one dimensional flow)

Problem 1:

Consider motionless air with $p_1 = 0.1$ atm and $T_1 = 300$ K in a constant area tube. It is required to accelerate this gas to Mach 1.5 by sending a normal shock wave down the tube. What is the wave velocity relative to the tube.

Problem 2:

Consider an incident normal shock wave that reflects from the end wall of a shock tube. The air in the driven section of the shock tube is at $p_1 = 0.01$ atm and $T_1 = 300$ K. The pressure ratio across the incident shock is 1050. Find:

(a) The reflected shock wave velocity relative to the tube.
(b) The pressure and temperature behind the reflected shock.

Problem 3:

Consider a centered, one dimensional, unsteady expansion wave propagating into quiescent air with $p_4 = 10$ atm and $T_4 = 2500$ K. The strength of the wave is given by $p_3/p_4 = 0.4$. Calculate the velocity and Mach number of the induced mass motion behind the wave, relative to the laboratory.

Problem 4:

The driver and driven gases of a pressure driven shock tube are both air at 300 K. If the diaphragm pressure ratio is $p_4/p_1 = 5$, calculate:

(a) Strength of the shock wave (p_2/p_1)
(b) Strength of the reflected shock wave (p_5/p_2)
(c) Strength of the incident expansion wave (p_3/p_4)
(d) If the uniform region behind the reflected expansion is denoted by 6. Calculate p_6/p_3 and temperature T_6 behind the reflected expansion wave.
(e) If the length of the driver is 5 m and the length of the driven section is 10 m – do you think the reflected expansion wave intersects the incident shock before it gets reflected?
(f) Draw x-t diagram of the whole process.