AS 203 Gas Dynamics
Practice Problems -3

Instructor: Dr. T. M. Muruganandam; Date: Mar 14, 2008

1. A convergent nozzle is connected to a stagnation chamber with air at 100atm and 1000K. If the ambient pressure is 60 atm, Find the exit velocity. Also find the exit velocity for an ambient pressure of 30 atm. [*524 m/s; 580.7 m/s*]

2. Find the velocities at the exit if the exit area is halved from the case in problem 1. Explain your results. [*524 m/s; 580.7 m/s; Only the mass flow rate will decrease, and the exit Mach number remains same.*]

3. There exists a Convergent-Divergent nozzle (CD nozzle) with inlet area as 0.1 m^2, throat area as 0.05 m^2 and the exit area as 0.2 m^2. This nozzle is replacing the convergent nozzle in problem 1. Find the three critical pressures for the nozzle. [98.51atm, 29.54atm, 2.98atm]

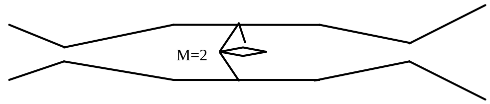
4. Find the net mass flow rate through the nozzle in problem 3 for ambient pressures of 99, 60, 30, 5 and 1 atm. [530.5 kg/s, 645.7 kg/s]

5. Air enters a CD nozzle of a rocket engine at a stagnation temperature of 3200K. The nozzle exhausts into an ambient pressure of 100kPa, and the exit-to-throat area ratio is 10. The thrust produced is 1300kN. Assume the expansion process to be complete and isentropic. Determine (a) the exit velocity and static temperature, (b) mass flow rate, (c) stagnation pressure, (d) throat and exit areas. [*2210 m/s, 784.8 K; 588 kg/s; 13.7 MPa; 0.06* m^2*; 0.6*m^2]

6. Consider a CD nozzle with exit and throat areas of 0.5 m^2 and 0.25 m^2 respectively. The inlet reservoir pressure is 100kPa and the exit pressure is 60kPa. Determine the exit Mach number and the thrust produced by the nozzle. [*0.47, 9.35 kN*]

7. A supersonic tunnel is designed to have first throat to be 0.1 m^2 and the exit area of the first nozzle is 0.5 m^2. What should be the second throat area for the test section to be supersonic? [*0.354* m^2]

8. There is a 100x100 mm^2 test section, M=2 tunnel if we are to place a 2D model in it, what is the maximum frontal thickness the model can have? What will happen if we exceed this size? [*17.7 mm*]



9. A symmetric double wedge with included angle of 20 degrees is to be placed in the tunnel in problem 8. Find the maximum length the model can have, if the shock from the front shall not interfere with the model after reflection at zero angle of attack. Lets assume that the shock is not affected by the interaction with expansion fans.