AS – 5680 High Temperature Gas Dynamics
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Supplementary Exercise – 1
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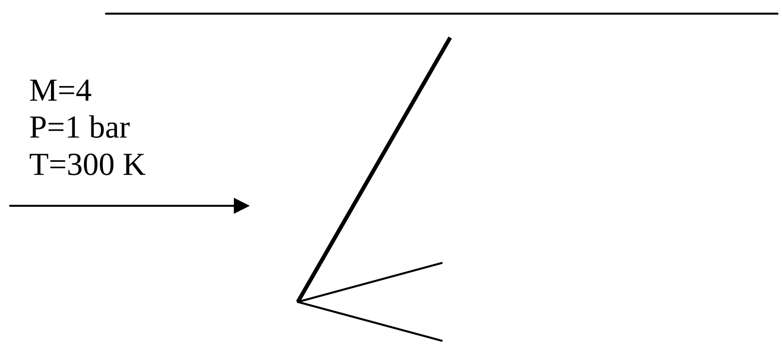
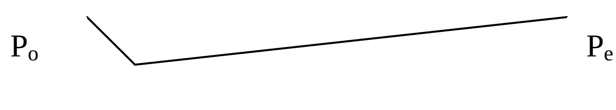
1. Consider supersonic flow of Mach 4 (T=300K, P=1bar) around a wedge in a supersonic test section. The wedge half angle w.r.t. horizontal is 15 degrees. The oblique shock from the leading edge interacts with the wall of the test section as illustrated in the figure. Find whether the shock will reflected directly or with a lambda shock reflection. Also calculate the flow conditions (P, T, M, U)



2. Consider a flat plate in a supersonic flow field. Find Lift and Drag on the flat plate as a function of angle of attack. Consider angles of attack in the range of 0 – 20 degrees. Also find the angle at which the flow is leaving the flat plate at the trailing edge for each angle of attack. Explain why it is nonzero when AOA is nonzero.

3. Plot the relationship between the oblique shock angle and the deflection caused by it for all possible shock angles for a given M. Do the above for three values of γ (1.66, 1.4, and 1.3).

3. Consider a convergent-divergent nozzle with converging angle of 45 degrees and diverging angle of 10 degrees.



This 2-D nozzle is designed to give a Mach 1.8 flow at the exit when perfectly expanded. Let us assume that the inlet and the exit areas are the same. The inlet section is connected to a huge reservoir which is maintained at pressure Po. The exit is exiting into another chamber of pressure Pe.

(a) Plot the pressure in the nozzle as a function of distance x/h_t, where h_t is the height of the throat, when Po is maintained constant and Pe is continuously decreased from Po to zero. Our focus is mainly in the flow inside the nozzle. So stop the calculations when there will be no more changes in the nozzle.
(b) Plot the pressure as a function of x/ht, when the Pe is maintained constant and Po is increased from Pe to infinity. Stop the calculations when there will be no more changes in the nozzle.