SPC 407
Matlab - Sheet 1
Compressible Flow - Governing Equations

1. Air at 200 kPa, 100 C, and Mach number M=0.8 flows through a duct. Calculate the velocity and the stagnation pressure, temperature, and density of the air. Using Matlab software, study the effect of Mach numbers in the range 0.1 to 2 on the velocity, stagnation pressure, temperature, and density of air. Plot each parameter as a function of the Mach number.
2. An ideal gas flows through a passage that first converges and then diverges during an adiabatic, reversible, steady-flow process. For subsonic flow at the inlet, sketch the variation of pressure, velocity, and Mach number along the length of the nozzle when the Mach number at the minimum flow area is equal to unity.
3. Repeat Prob. 2 for supersonic flow at the inlet.
4. Air at 900 kPa and 400 K enters a converging nozzle with a negligible velocity. The throat area of the nozzle is 10 cm^2. Approximating the flow as isentropic, calculate and plot the exit pressure, the exit velocity, and the mass flow rate versus the back pressure P_b for $0.9 \geq P_b \geq 0.1$ MPa.
5. Reconsider Prob. 4. Using Matlab software, solve the problem for the inlet conditions of 0.8 MPa and 1200 K.
6. Consider air flowing at high-speed through a convergent-divergent nozzle having a circular cross-sectional area, A, that varies with axial distance from the throat, x, according to the formula
   $A = 0.1 + x^2$; $-0.5 < x < 0.5$
   where A is in square meters and x is in meters. The stagnation pressure po at the inlet is 101,325 Pa. The stagnation temperature T_o at the inlet is 300 K. The static pressure p at the exit is 3,738.9 Pa. Calculate the Mach number, pressure and temperature distribution in the nozzle using Matab and compare the solution to FLUENT Tutorial results.