SPC 407
Sheet 1
Compressible Flow - Governing Equations

1. A high-speed aircraft is cruising in still air. How does the temperature of air at the nose of the aircraft differ from the temperature of air at some distance from the aircraft?
2. In air-conditioning applications, the temperature of air is measured by inserting a probe into the flow stream. Thus, the probe actually measures the stagnation temperature. Does this cause any significant error?
3. Air flows through a device such that the stagnation pressure is 0.6 MPa, the stagnation temperature is 400 °C, and the velocity is 570 m/s. Determine the static pressure and temperature of the air at this state.
4. Air at 320 K is flowing in a duct at a velocity of (a) 1, (b) 10, (c) 100, and (d) 1000 m/s. Determine the temperature that a stationary probe inserted into the duct will read for each case.
5. Calculate the stagnation temperature and pressure for the following substances flowing through a duct: (a) helium with c_p = 5.1926 kJ/kg·K and k = 1.667 at 0.25 MPa, 50 °C, and 240 m/s; (b) nitrogen with with c_p = 1.039 kJ/kg·K and k = 1.4 at 0.15 MPa, 50 °C, and 300 m/s; and (c) steam gas with c_p = 1.865 kJ/kg·K and k = 1.329 at 0.1 MPa, 350 °C, and 480 m/s.
6. Air enters a compressor with a stagnation pressure of 100 kPa and a stagnation temperature of 358 °C, and it is compressed to a stagnation pressure of 900 kPa. Assuming the compression process to be isentropic, determine the power input to the compressor for a mass flow rate of 0.04 kg/s.
7. Products of combustion enter a gas turbine with a stagnation pressure of 0.75 MPa and a stagnation temperature of 690 °C , and they expand to a stagnation pressure of 100 kPa. Taking c_p = 1.157 kJ/kg.K, k = 1.33 and R = 0.287 kJ/kg·K for the products of combustion, and assuming the expansion process to be isentropic, determine the power output of the turbine per unit mass flow.