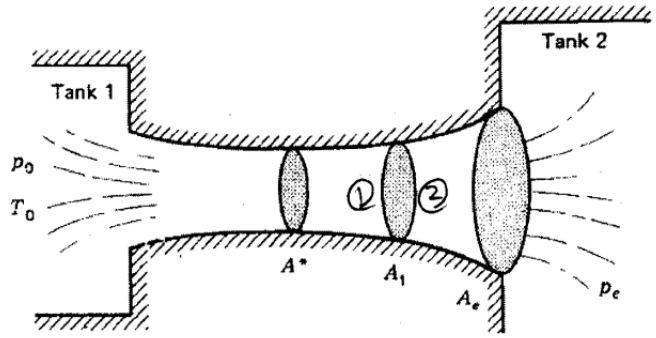
Homework

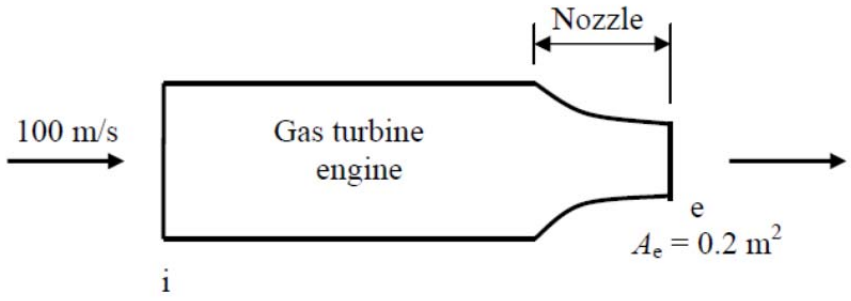
Due Date: 21/1/1392

A stream of air flows through a convergent-divergent nozzle attached to a chamber (tank 1) where the pressure is 689.5 kPa and the temperature is 93 °C. The area of the throat is 7.62 cm^2 and A_1, where we happen to have a normal shock, is 10.16 cm^2. Finally A_e, is 15.24 cm^2. What is the Mach number right after the shock wave? What is the Mach number at exit? Compute the stagnation pressure and actual pressure for the jet in tank 2. What is the stagnation temperature at exit?

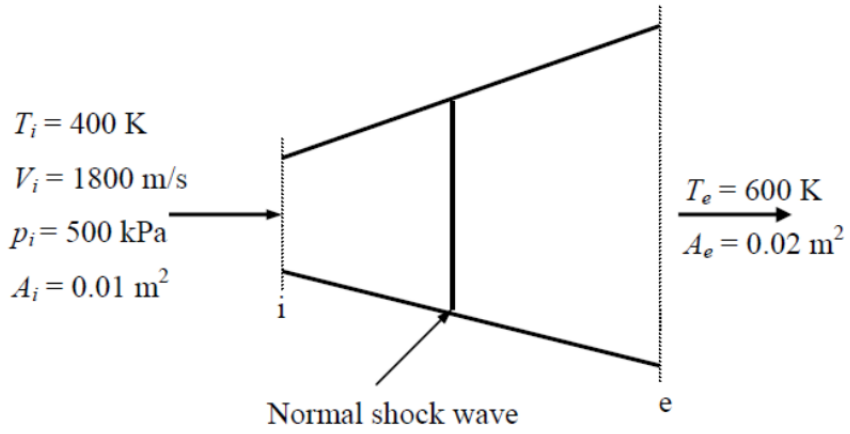


A nozzle for an ideal rocket is to operate at an altitude of 15.25 km, where the pressure is 11.60 kPa, and is to give a 6.67-kN thrust when the chamber pressure is 1345 kPa and the chamber temperature is 2760 °C. Determine the throat and exit areas and the exit velocity and temperature. Take $\gamma = 1.4$ and $R = 0.355$ kJ/kg. K, and assume the exit pressure to be the ambient pressure.

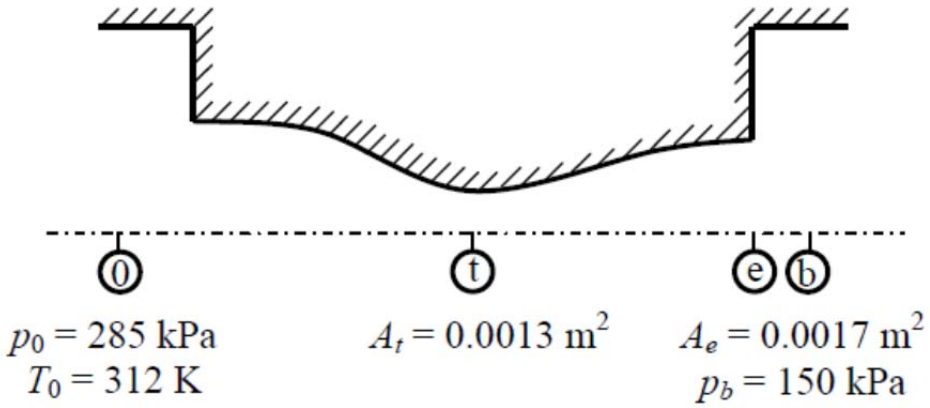
A gas turbine engine produces a thrust of 10000 N while the gas is entering to the engine, at a velocity of 100 m/s. The mass flow rate through the engine is 50 kg/s. The nozzle exit area is 0.2 m^2. The atmospheric pressure is 100 kPa and the nozzle is not choked. Find the Mach number at the exit of the nozzle. The specific heat ratio and the specific heat under constant pressure are 1.33 and 1150 J/kgK for the exhaust gasses, respectively. **(Ans. 0.7509)**



Helium enters a converging duct with a velocity of 1800 m/s, a temperature of 400 K and a pressure of 500 kPa. The flow undergoes a normal shock wave, as shown in the figure. The temperature at the exit of the duct is 600 K. The cross-sectional areas at the inlet of the duct are 0.01 m^2 and 0.02 m^2, respectively. Assuming adiabatic flow, determine the force which is required to hold the duct in place. **(Ans. -284.1 N)**



A converging-diverging nozzle is fed with air from a large reservoir, where the pressure and temperature are 285 kPa and 312 K, respectively. The exit and throat cross-sectional areas of the nozzle are 0.0017 m^2 and 0.0013 m^2, respectively. If the nozzle discharges into a region with a pressure of 150 kPa, determine the Mach number, pressure and temperature at the exit of the nozzle. Also, find the mass flow rate. Assume adiabatic and frictionless flow.



A converging–diverging nozzle (Figure P5.16) discharges air into a receiver where the static pressure is 15 psia. A 1-ft^2 duct feeds the nozzle with air at 100 psia, 800°R, and a velocity such that the Mach number $M_1 = 0.3$. The exit area is such that the pressure at the nozzle exit exactly matches the receiver pressure. Assume steady, one-dimensional flow, perfect gas, and so on. The nozzle is adiabatic and there are no losses.

(a) Calculate the flow rate.

(b) Determine the throat area.

(c) Calculate the exit area.