Exercise problem # 1

A small inward radial flow gas turbine, comprising a ring of nozzle blades, a radial-vaned rotor and an axial diffuser, operates at the nominal design point with a total-to-total efficiency of 0.90. At turbine entry the stagnation pressure and temperature of the gas is 400 kPa and 1140 K. The flow leaving the turbine is diffused to a pressure of 100 kPa and has negligible final velocity. Given that the flow is just choked at nozzle exit, determine the impeller peripheral speed and the flow outlet angle from the nozzles.

Ans: 586 m/s, 73.75^{o}

Exercise problem # 2

If the mass flow rate of gas through the turbine given in Problem # 1 is 3.1 kg/s, the ratio of the rotor axial width–rotor tip radius ($b2/r2$) is 0.1 and the nozzle isentropic velocity ratio is 0.96. Assuming that the space between nozzle exit and rotor entry is negligible and ignoring the effects of blade blockage, determine (i) the static pressure and static temperature at nozzle exit; (ii) the rotor tip diameter and rotational speed; (iii) the power transmitted assuming a mechanical efficiency of 93.5%.

Ans: (i) 205.8 kPa, 977 K, (ii) 125.44 mm, 89, 200 rpm (iii) 1 MW