Exercise Problem # 1

An axial flow turbine operating with an overall stagnation pressure of 8 to 1 has a polytropic efficiency of 0.85. Determine the total-to-total efficiency of the turbine. If the exhaust Mach number of the turbine is 0.3, determine the total-to-static efficiency. If, in addition, the exhaust velocity of the turbine is 160 m/s, determine the inlet total temperature.

Ans: 88%, 86.17%, 1170.6 K

Exercise Problem # 2

The mean blade radii of the rotor of a mixed flow turbine are 0.3 m at inlet and 0.1 m at outlet. The rotor rotates at 20,000 rev/min and the turbine is required to produce 430kW. The flow velocity at nozzle exit is 700 m/s and the flow direction is at 70° to the meridional plane. Determine the absolute and relative flow angles and the absolute exit velocity if the gas flow is 1 kg/s and the velocity of the through-flow is constant through the rotor.

Ans: α_2=70 deg, β2=7.02 deg, α_3=18.4 deg, β_3=50.37 deg

Exercise Problem # 3

An axial flow gas turbine stage develops 3.36MW at a mass flow rate of 27.2 kg/s. At the stage entry the stagnation pressure and temperature are 772 kPa and 727°C, respectively. The static pressure at exit from the nozzle is 482 kPa and the corresponding absolute flow direction is 72° to the axial direction. Assuming the axial velocity is constant across the stage and the gas enters and leaves the stage without any absolute swirl velocity, determine (a) the nozzle exit velocity; (b) the blade speed; (c) the total-to-static efficiency; (d) the stage reaction.

Ans: 488m/s, 266.1 m/s, 0.83, 0.128

Exercise Problem # 4

A single stage axial turbine has a mean radius of 30 cm and a blade height at the stator inlet of 6 cm. The gases enter the turbine stage at 1900 kPa and 1200 K and the absolute velocity leaving the stator is 600 m/s and inclined at an angle of 65 deg to the axial direction. The relative angles at the inlet and outlet of the rotor are 25 deg and 60 deg respectively. If the stage efficiency is 0.88, calculate (a) the rotor rotational speed, (b) stage pressure ratio (c) flow coefficient (d) degree of reaction and (e) the power delivered by the turbine.

Ans: 13550 rpm, 2.346, 0.6, 0.41, 34.6 MW