Assignment

1) A turbine in a steam power plant operating under steady state conditions receives one Kg/s of superheated steam at 3MPa and 350°C with a velocity of 50 m/s at an elavation of 2 m above the ground level. The steam leaves the turbine at 10 KPa with a quality of 0.95 at an elavation of 5 m above the ground level. The exit velocity of the steam is 120 m/s. The energy losses as heat from the turbine are estimated at 5 KJ/s. Estimate the power output of the turbine. How much error will be introduced if the Kinetic energy and the potential energy terms are ignored?

Ans: 637.73 kW, 0.93%, 0.0046 %

2) In an air-conditioning plant, saturated freon-12 at -20°C with a quality of 0.8 enters an adiabatic compressor and leaves as saturated vapor at 40°C. If the flow rate of freon through the compressor is one kg/s, estimate the power input to the compressor.

Ans: 56.394 kW

3) Air enters a well insulated compressor operating at steady state at 1 bar and 300 K and exits at 6 bar and 440 K. If the flow rate of air through the compressor is 3 kg/s, Calculate the power consumption of the compressor.

Ans: 421.97 kW

4) In a steam power plant, saturated liquid water at 10 KPa enters a feed pump at the rate of one kg/s. The feed pump delivers the water to the boiler at a pressure of 3 MPa. Assuming that the pump is adiabatic, estimate the power input to the pump.

Ans: 3.02 kW

5) Steam enters an adiabatic nozzle operating at steady state at 4 bar and 200°C with negligible velocity, and exits at 2 bar and velocity of 300 m/s. Determine the temperature of steam leaving the nozzle.

Ans: 217.3°C

6) Air (ideal gas with $\gamma = 1.4$) expands reversibly and adiabatically through a Nozzle from inlet conditions of 3 bar and

300°C to an exit pressure of 1 bar. Determine the exit velocity and the mass flow rate if the exit area is 5×10^{-4} m^2.

Ans: 297.66 m/s, 0.1239 kg/s

7) A nozzle receives 5 kg/s of steam at 3 bar and 300°C and discharges it at 1 bar and 200°C. The inlet velocity of the steam is negligible and the energy loss to surroundings in the form of heat is estimated to be 50 KJ/s. Determine the discharge velocity of the steam.

Ans: 607.12 m/s

8) A throttling calorimeter is used to measure the quality of steam in a pipe where the pressure is 10 bar. The conditions in the calorimeter are 1 bar, and 120°C. Determine the quality of steam in the pipeline.

Ans: 0.97

9) When wet steam at 10 bar is throttled to 1 bar, the temperature of the exit steam is 110°C. Determine the Quality of steam.

Ans: 0.96

10) In a commercial refrigerator, the refrigerant (saturated liquid freon-12 at 40°C) is throttled to the low temperature of -26°C. Determine the Quality of freon-12 after throttling.

Ans: 0.3825

11) Saturated vapor freon-12 enters a steady flow adiabatic device (at 5 bar) with a velocity of 2 m/s. The freon-12 leaves the device as saturated vapor at 1 bar. Calculate the exit velocity.

Ans: 199.31 m/s

12) Air enters an adiabatic nozzle at 3 bar and 200°C with a velocity of 10 m/s ~~enters a reversible and adiabatic nozzle with negligible velocity~~ and leaves at 2 bar and 150°C. Calculate the exit velocity of the air.

Ans; 317.13 m/s

13) Air at 3 bar and 200°C enters a reversible and adiabatic nozzle with negligible Velocity and leaves at 2 bar. Calculate the exit velocity of the Air.

Ans: 322.44 m/s

14) In a small gas turbine operating under steady state conditions, air enters at 3 bar, 400 K. The turbine discharges air at 1 bar, and 320 K. Ignoring the changes in kinetic energy, estimate the flow rate of air, if the power output of the turbine is 15 kW.

Ans: 0.1866 Kg/s

15) Steam at 20 bar and 220°C enters a throttling valve and exhausts at 5 bar. Determine the temperature and specific volume of the exhaust steam.

Ans: 182.96°C, 0.4072 m^3/Kg

16) A 1 m^3 tank contains air (ideal gas with $\gamma = 1.4$) at 100 kPa and 300 K. Attached to this tank a line in which air is flowing at 1 MPa and 600 K. The air from this line enters the tank until pressure reaches 1 MPa. If there is no energy transfer as heat from the tank, calculate the temperature of air in the tank, and quality of air that enters the tank.

Ans: 711.86 K, 3.7334 Kg