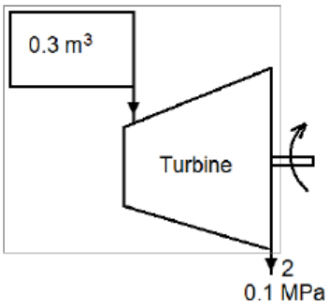
TUTORIAL-5 (12 Feb 2019)
Thermodynamics for Aerospace Engineers (AS1300)

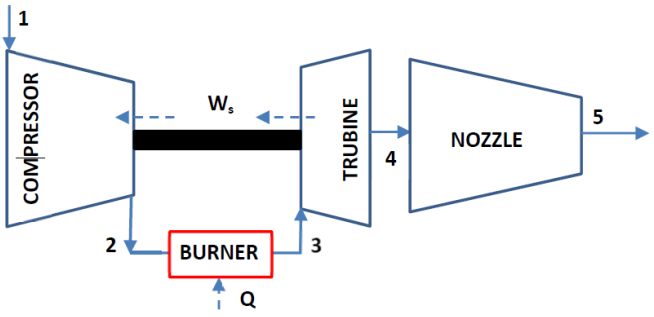
1. A gated community of 100 houses has exactly same type of houses (each 100 m^2 area and inner air volume of 540 m^3 and volume of the whole house (including air) is 700m^3) built in a square pattern of 10x10 in a square area of 10000 m^2 area. Outside temperature of the atmosphere is 35 deg C. All the houses have a temperature setting of 20 deg C. Assume all the houses start out with same temperature as ambient and get cooled to 20 deg C. This information is to be used only for finding the heat removed from the rooms. If each of the houses had two Air conditioners of 2 Tonne capacity, find the heat rejected by the community into atmosphere. Assume the COP of the ACs to be 3. Also find the increase in temperature of the atmosphere around the community if all the rejected heat is used to raise the temperature of the ambient around the community of same floor area of 10000 m^2 and a height of 15 m (remember to remove the volume of the houses).

2. In a gas turbine the gas enters at the rate of 6kg/s with a velocity of 60 m/s and enthalpy of 900 kJ/kg leaves the turbine with a velocity of 150 m/s and enthalpy of 400 kJ/kg. The loss of heat from the gases to the surroundings is 28 kJ/kg. Assume for gas R= 288.6 J/kgK and cp = 1000 J/kgK and inlet conditions to be at 100 kPa and 27°C. Determine the power output of the turbine.

3. A tank of volume 0.3 m^3 is initially filled with air at a pressure and temperature of 3.5 MPa and 400°C. The air is now allowed to discharge slowly through a turbine into the atmosphere until the pressure in the tank falls to the atmospheric pressure of 0.1MPa. Determine the work developed by the turbine. Neglect friction, heat loss, KE & PE changes.



4. An aircraft gas turbine engine has air mass flow rate of 100 kg/s. The air enters compressor at inlet temperature of 300K and 1atm absolute pressure. The compressed air at 18 atm from compressor is heated (Q) in a burner to 1700K and expanded in a turbine. The shaft work output (Ws) from turbine is used for driving the compressor.
a) Calculate the gas temperature at the exit of the turbine.
b) If the nozzle-exit temperature is 600K. What is the exhaust velocity (V5) of gases coming out of the nozzle?
In each of the above parts clearly indicate the *appropriate control volume*.



5. Two reversible cycles are arranged in series. The first cycle receives energy from a reservoir at TH and rejects energy to a reservoir at an intermediate temperature T. The second cycle receives energy rejected by the first cycle to the reservoir at T and rejects energy to a reservoir at a

temperature TC lower than T. Derive an expression for the intermediate temperature T in terms of TH and TC, when

(a) The net works of the two cycles are equal.

(b) The thermal efficiencies of the two cycles are equal.