CANKAYA UNIVERSITY
**FACULTY OF ENGINEERING AND ARCHITECTURE**
MECHANICAL ENGINEERING DEPARTMENT
**ME 211 THERMODYNAMICS I**

FALL 2016

HW # 6

1) A well-insulated rigid tank contains 3 kg of a saturated liquid–vapor mixture of water at 200 kPa. Initially, three-quarters of the mass is in the liquid phase. An electric resistance heater placed in the tank is now turned on and kept on until all the liquid in the tank is converted to saturated vapor. Determine the entropy change of the steam during this process.
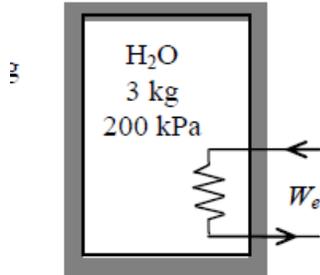

2) An insulated piston–cylinder device contains 5 L of saturated liquid water at a constant pressure of 150 kPa. An electric resistance heater inside the cylinder is now turned on, and 2200 kJ of energy is transferred to the steam. Determine the entropy change of the water during this process.
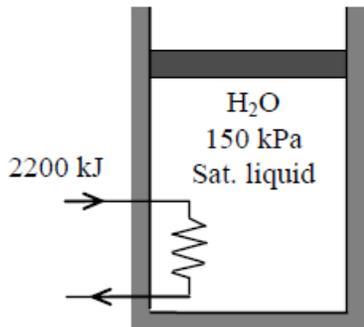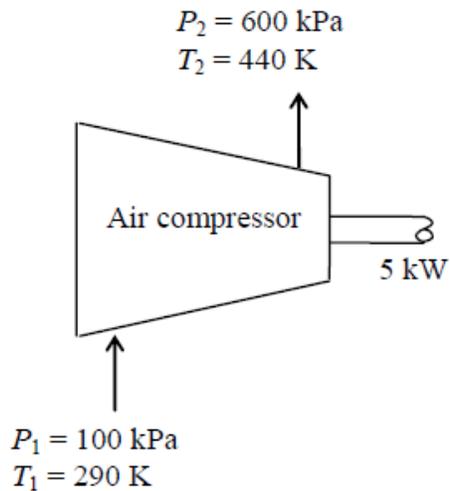
3) Steam enters an adiabatic turbine at 6 MPa and 500 °C and leaves at a pressure of 0.3 MPa. Determine the maximum amount of work that can be delivered by this turbine.

1

H_2O

2
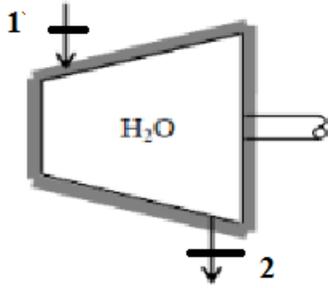
4) An isentropic steam turbine processes 2 kg/s of steam at 3 MPa, which is exhausted at 50 kPa and 100 °C. 5 percent of this flow is diverted for feedwater heating at 500 kPa. Determine the power produced by this turbine, in kW.

3 MPa
2 kg/s

Steam
turbine

500 kPa

50 kPa
100°C
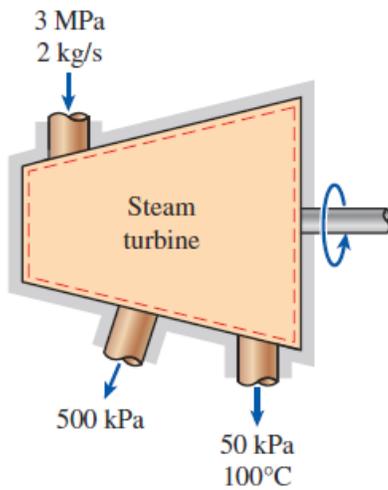
5) Air is compressed steadily by a 5-kW compressor from 100 kPa and 17 °C to 600 kPa

$P_2 = 600$ kPa
$T_2 = 440$ K

Air compressor

5 kW

$P_1 = 100$ kPa
$T_1 = 290$ K

and 167 ^{0}C at a rate of 1.6 kg/min. During this process, some heat transfer takes place between the compressor and the surrounding medium at 17 ^{0}C. Determine the rate of entropy change of air during this process.

$P_2 = 600$ kPa
$T_2 = 440$ K

Air compressor

5 kW

$P_1 = 100$ kPa
$T_1 = 290$ K
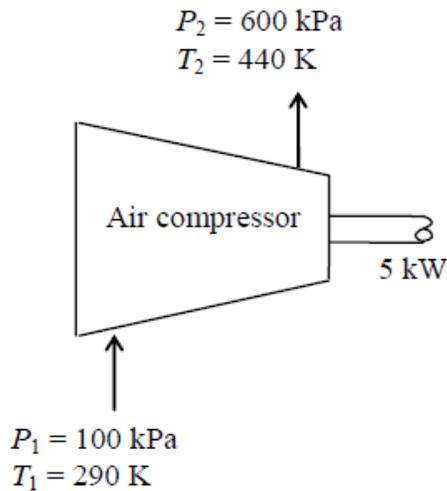
6) Steam at 4 MPa and 350 ^{0}C is expanded in an adiabatic turbine to 120 kPa. What is the isentropic efficiency of this turbine if the steam is exhausted as a saturated vapor?

$P_1 = 4$ MPa
$T_1 = 350°C$

Steam
turbine

$P_2 = 120$ kPa
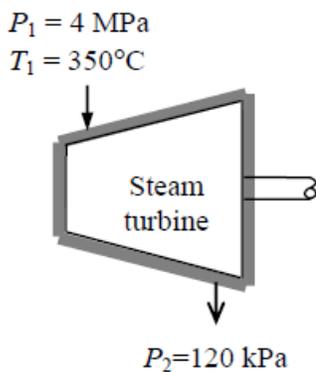
7) Steam enters an adiabatic turbine steadily at 7 MPa, 500 ^{0}C, and 45 m/s, and leaves at 100 kPa and 75 m/s. If the power output of the turbine is 5 MW and the isentropic efficiency is 77 percent, determine (a) the mass flow rate of steam through the turbine, (b) the temperature at the turbine exit, and (c) the rate of entropy generation during this process.

Steam, 7 MPa
500°C, 45 m/s

Turbine
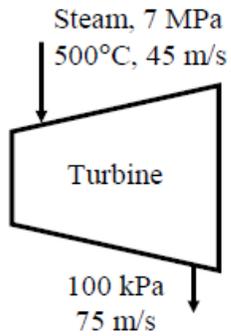
100 kPa
75 m/s

8) Water at 200 kPa and 10 °C enters a mixing chamber at a rate of 135 kg/min where it is mixed steadily with steam entering at 200 kPa and 150 °C. The mixture leaves the chamber at 200 kPa and 55 °C , and heat is lost to the surrounding air at 20 °C at a rate of 180 kJ/min. Neglecting the changes in kinetic and potential energies, determine the rate of entropy generation during this process?

180 kJ/min

$T_1 = 10\,^0C$

1

135 kg/min

$T_3 = 55^0C$

3

p=200 kPa

$T_2 = 115\,^0C$

2