Hints and answers, Exercice 2

(note: decimal sign here is comma)

Problem 1

You have to use the isentropy relation pv^k=constant, and the equation of state for ideal gases. Kinetic energy must be included in the 1st law.

Answers: 245 K and 675 m/s

Problem 2:

a) If the system boundary is laid around the container and the throttle valve (other alternatives are possible), the 1st law becomes $H_{inn} = U_2 - U_1$.
b) Hint: Use the mass balance, the equation of state, the 1st law, and the definition of enthalpy (h). Answer: 400 K

Problem 3:

(Let states 1 and 2 be inlet and outlet of the compressor; state 3 and 4 inlet and outlet of the turbine.)

c) Hint: Use the isentropic efficiency and the isentropy relation (see Probl. 1) to determine T_2 (=494 K). Then, determine the work from 1st law. We assume the compressor adiabatic. Answer: -194 kJ/kg.
d) Hint: Approximately similar to c). Answer: 366 kJ/kg
e) Answer: 0,28

Hints and answers, Exercice 3

Problem 1

a) Hint: Put up reversible heat engines between each of the bodies and the surroundings, or calculate the change of exergy in thetwo bodies. Answer: The minimum supplied woek is $T_0 m_A C_A \ln(T_A / T_{AB}) + T_0 m_B C_B \ln(T_B / T_{AB})$
b) Hint: Use 1st and 2nd laws for the reversible engine (note that both temperatures vary). Integration over the change gives $\ln(T_2 / T_B) = -(m_A C_A)/(m_B C_B) \cdot \ln(T_2 / T_A)$. Then, resolve the end temperature T_2.

Problem 2

a) Answer: 59,4 kJ/kg

Problem 3

c) You have to make an asumption about the state of the flow leaving the turbine. The best you theoretically can achieve, is isentropic expansion – then the answer will be 0,32. If you require saturated steam (no condensing), the answer will be 0,21 – but then the isotropic efficiency is as low as 0,63 (0,85-0,90 is realistic).