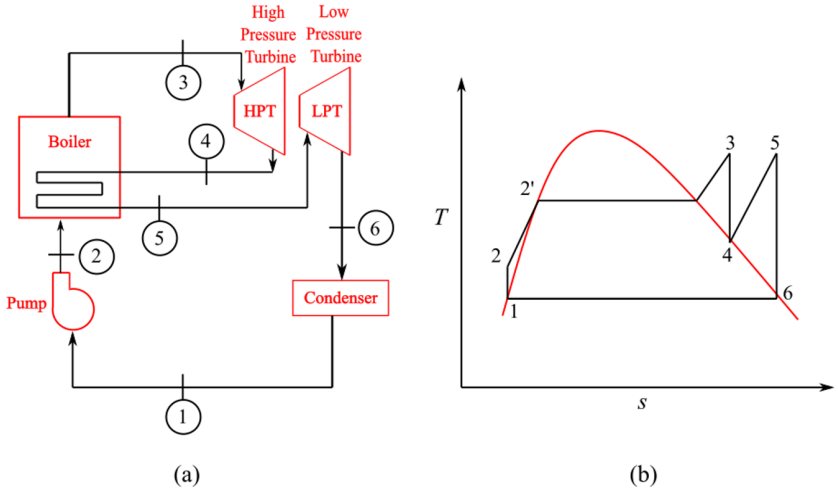
Assignment 6

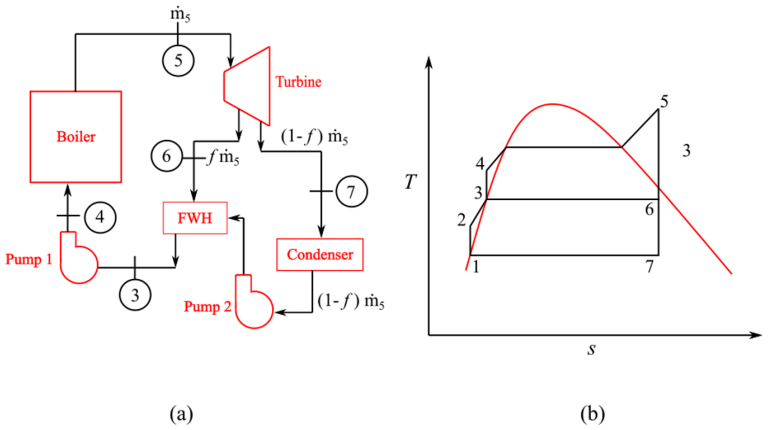
Q1. Let us consider an ideal steam reheat cycle as shown in Figure below. The steam enters the high pressure turbine at 4 MPa, 400 °C and then expands to a pressure of 0.4 MPa. It is then reheated to 400 °C at a constant pressure of 0.4 MPa and fed to the low pressure turbine where it expands to 10 kPa. Calculate the thermal efficiency and quality of the steam at the outlet of the low pressure turbine. Write a python program to solve the problem, use the PYroMat package to retrieve the required steam table information.



(a) (b)

Fig. 1: Ideal Rankine cycle with reheating

Q2. Consider an ideal regenerative cycle in which the steam enters the turbine at 4 MPa and 400 °C and exhausts to the condenser at 10 kPa. Steam is extracted from the turbine at 0.4 MPa for an open feedwater heater. The feedwater leaves the heater as saturated liquid. The appropriate pumps are used for water leaving the condenser and the feedwater heater. Calculate the thermal efficiency of the cycle and the net work per kilogram.Write a python program to solve the problem, use the PYroMat package to retrieve the required steam table information.



(a) (b)

Fig. 2: Ideal Rankine cycle with regeneration

Q3. Prepare the PV (Pressure Volume), TS (Temperature-Entropy) and P-h (Pressure-Enthalpy) diagrams showing the vapour dome for the following fluids. Highlight the liquid saturation and vapor saturation lines in different colours. Choose proper scales for the axes in order to highlight steep changes in magnitudes.

(i) H_2O (ii) R-22 (iii) R-134a

[Bonus points for making the charts user-interactive]

Q4. Demonstrate the phenomenon of anomalous expansion of water on cooling between 4 °C and 0 °C. Take an overall temperature range from 0 to 10 °C. Use the CoolProp library to retrieve the required properties.

Q5. Consider 100 m^3 of an air-water mixture at 0.1 MPa, 35 °C (Dry bulb temperature), and 70% relative humidity. Write a python code to evaluate the following. Use the CoolProp library.

(i) Find the enthalpy of the mixture per unit dry air and per unit moist air
(ii) Find the entropy of the mixture per unit dry air and per unit moist air
(iii) Find humidity ratio, dew point, mass of air and mass of vapour.
(iv) Find the viscosity (μ) and the wet bulb temperature of the mixture.

Q6. 1 kg/s of saturated moist air (RH = 100%) at 100 kPa and 10 °C goes through a heat exchanger and comes out at 25 °C. What is the exit RH and how much power is needed. Write a python code to solve the given problem. Use the CoolProp library to retrieve properties of humid air.

Q7. Consider 1 m^3/s of atmospheric air at 100 kPa, 25 °C and 80% relative humidity. This air flows into a basement where it cools to 15 °C at 100 kPa. How much liquid will condense out per hour? Write a python code to solve the problem. Use the CoolProp library to retrieve properties of humid air.