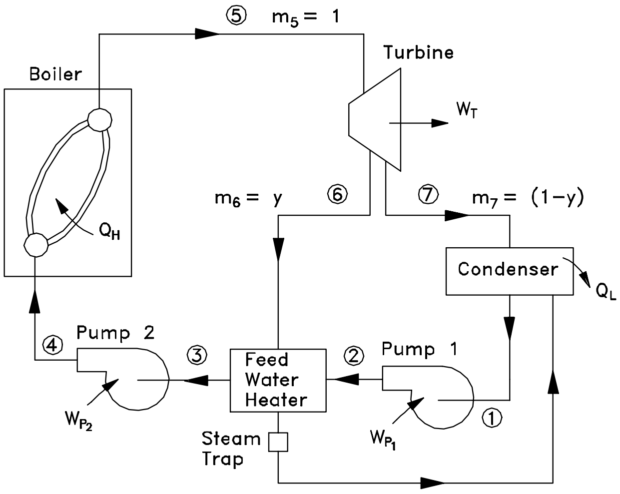
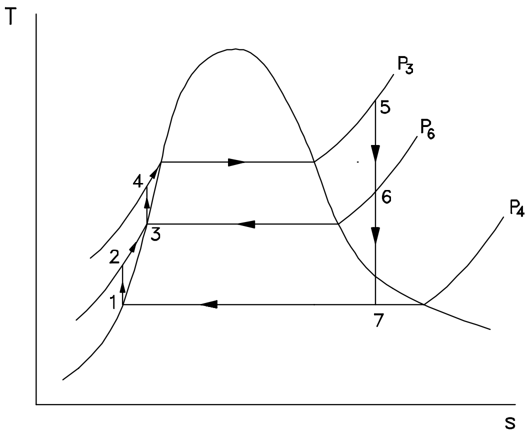
Week 4: Lecture 3

Rankine Cycle with Regeneration

- Carnot cycle has efficiency - $\eta = 1 - T_L/T_H$
  - add Q_H at as high a T_H as possible
  - reject Q_L at as low a T_L as possible
- the Rankine cycle can be used with a "Feedwater Heater" to heat the high pressure sub-cooled water at the pump exit to the saturation temperature
  - most of the heat addition (Q_H) is done at high temperature





Week 4: Lecture 3

Feedwater Heaters

1. **OPEN FWH** - streams mix $\rightarrow$ high temperature steam with low temperature water at constant pressure)
   - working fluid passes isentropically through the turbine stages and pumps
   - steam enters the first state turbine at state 1 and expands to state 2 - where a fraction of the total flow is bled off into an open feedwater heater at P_2
   - the rest of the steam expands into the second stage turbine at state point 3 - this portion of the fluid is condensed and pumped as a saturated liquid to the FWH at P_2
   - a single mixed stream exists the FWH at state point 6
2. **CLOSED FWH** - heat exchangers, streams do not mix (different pressures)
   - the incoming feedwater does not mix with the extracted steam
   - both streams flow separately through the heater
   - this allows the two streams to be at different pressures
   - a steam trap which allows only liquid to pass, is inserted in the condensed steam line, leaving the heater to insure all the extracted steam condenses before it leaves the heater
   - the condensate is then passed to the low pressure line of the condenser