Problem 1: *Figure 1 shows a schematic of a geothermal binary cycle operating with groundwater-steam (high temperature) and isopentane (low temperature) fluids in the dual cycle.*

(a) *'Cold groundwater' is injected in injection well whereas hot water/steam is recuperated in the production well. In other words, subcooled water displaces water/steam trapped in the porous media (or is heated up by hot geological formations), and this is driven to the production well. Discuss the set of physical phenomena in this process:*

- *multiphase flow in porous media (Darcy law),*
- *phase change (thermodynamic dome, temperature $\times$ entropy and pressure $\times$ enthalpy diagrams) and,*
- *heat transfer (conduction and convection) mechanisms.*

(b) *Analyse the isopentane thermodynamic cycle. Assume it works in an ideal Rankine Cycle.*

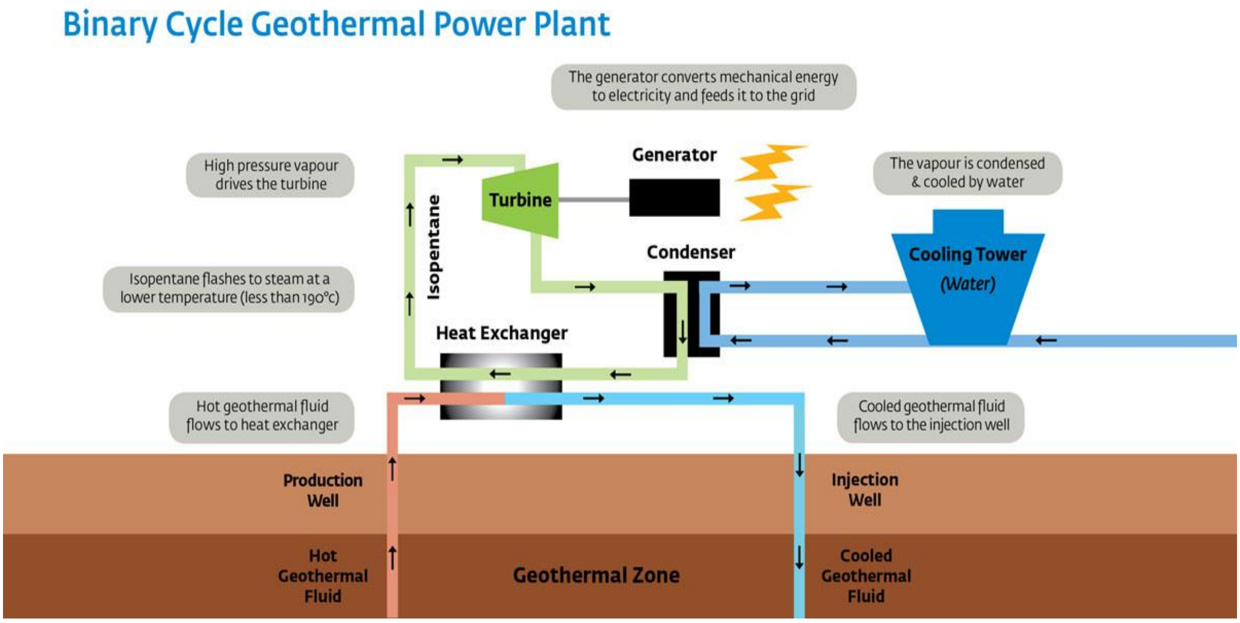

Figure 1: Binary cycle: Problem **Problem 1:**.

Problem 2: *A geothermal power plant uses groundwater extracted at 150^{o}C at a rate of 210 kg.s^{-1}. The plant produces 8000 kW of net power. The groundwater leaves the plant at 90^{o}C. If the environment temperature is 25^{o}C, calculate:*

(a) *Actual thermal efficiency;*

(b) *Maximum possible thermal efficiency;*

(c) *Actual rate of heat rejection from the power plant.*

Problem 3: *R-22 is the refrigerant fluid in a geothermal heat pump system for a house (Fig. 2). The heat pump uses underground water from a well* $\left(T_w^{in} = 13^oC; T_w^{out} = 7^oC\right)$ *to produce a heating capacity of 4.2 tons. Determine:*

(a) *Volumetric flow rate of heated air to the house* $\left(m^3/s\right)$*;*

(b) *Isentropic efficiency* (η_c) *and power* $\left(\dot{W}_c\right)$ *of the compressor;*

(c) *Coefficient of Performance;*

(d) *Volumetric flow rate of water from the geothermal well* (l/h)*;*

(e) *Sketch the* TS *diagram.*

Given the heat capacity $\left(C_p^{air} = 1.004\frac{kJ}{kg.K}\right)$ *and molecular weight* $\left(MW^{air} = 28.97\frac{kg}{kgmol}\right)$ *of air and heat capacity of water* $\left(C_p^{water} = 4.1813\frac{kJ}{kg.K}\right)$.

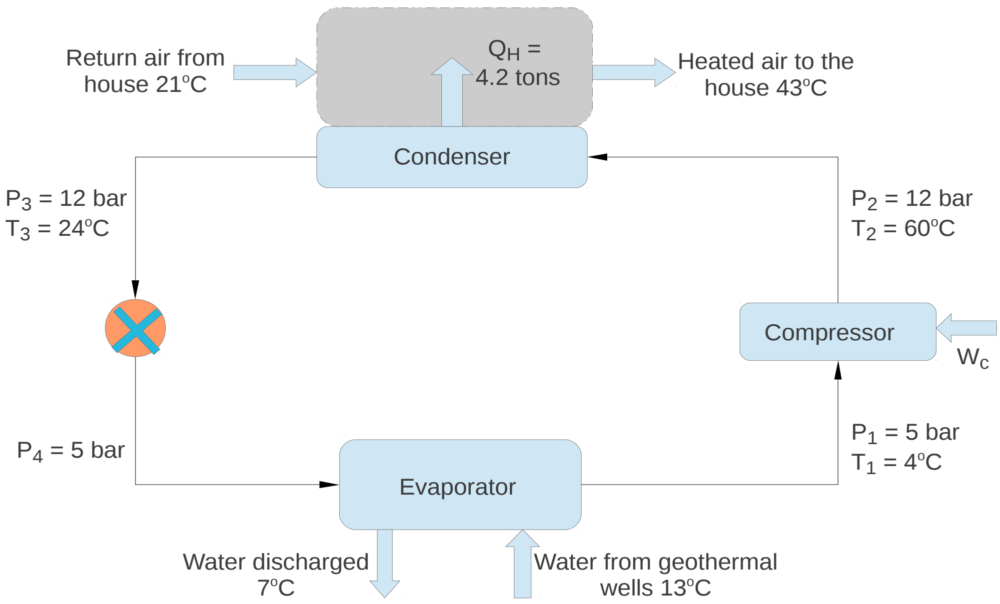

Figure 2: Heat pump cycle: Problem **Problem 3:**.

Deliverables:

- Solve this set of Problems and submit the solutions as **PDF** file through Turnitin. Thermodynamic tables for water-steam and R22 fluid are available in MyA (under the Lecture folder), if you decide to use any other data source (e.g., electronic), do indicate the thermodynamic values used in your calculations.
- The filename of the report should be **EG501J_CA_XXX.pdf** (**XXX** to be replaced by your surname).
- Submit your work by **Sunday, October 26th 2014, 23:59** at the latest.
- Penalties for late or non-submission are as follows: for late submission, 1 CGS mark will be deducted for each day late (including weekends); submission later than 7 days after the deadline will be considered as non-submission and a CGS mark of 0 will be awarded.
- Remember to include in your electronic submission a completed plagiarism cover sheet.
- Note that the submitted work is part of the continuous assessment which will contribute to your EG501J mark.