Question 1

The figure below shows a double flash power plant setup.

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1. Name all components shown in the figure, with a short notice on their purpose (one sentence each). Refer to the capital letters on the figure, A-H.
2. Draw a schematic T-s diagram (pressure entropy) of the power cycle. Use the numbers in the figure to indicate operating points on the diagram.
3. Draw a T-H diagram of the process in the condensers. Note that H denotes the specific enthalpy multiplied with mass flow.
4. If the mass flows and specific enthalpies are known in points 5 and 11, show how to calculate the mass flow and enthalpy in point 12.
5. Indicate how the first law efficiency should be calculated for this power plant.
6. Describe one other setup for a double flash power plant.

Question 2

The figure below shows a gas extraction system connected to a single flash power plant.

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1. Name all components shown in the figure and describe their purpose.
2. At what temperature should gases be extracted from a condenser, in relation to the saturation temperature in the condenser? How does this temperature affect the efficiency of the extraction?
3. Which typical types of gases need to be extracted? How does the type of gas affect the extraction performance when comparing same mass flow for two gases?

Question 3

1. (10%) Your task is to select the optimum pipe diameter for water pumping between X to Y. Describe the optimization procedure. Keywords: Installation cost, maintenance cost, pressure drop, electricity cost and present value of future payments. Use imaginary numbers and graphical presentation as needed.
2. (10%) Describe and discuss different piping layout arrangements, using one big steam separation station or using one separator at each well head. Name advantages and disadvantage of different arrangements. Keywords: Separator, brine tank, well pad level, separator station level, piping, re-injection, pumping, wells with different enthalpy, wells with different fluid chemistry etc.
3. (5%) Describe basic function of a horizontal gravity drum separator and a vertical cyclone separator. Use schematic drawings and sketches as needed.

d, (5%) Describe different ways of removing non-condensable gas from a condenser of a geothermal power plant and explain the importance of the gas cooling section of the main condenser.

e. (5%) Provide a short description and comparison on different cold end (condenser and cooling tower) options for geothermal power plants.

Question 4

1. (10%) Describe the main phases of geothermal development project (from beginning of exploration and into the operational period). Include and discuss cost- and risk distribution for the project lifetime. Keywords: Exploration, feasibility, Construction, Operation
2. (10%) Describe the main cost items in a geothermal power plant. Both capital and operational cost. Identify and discuss the main influential parameters of the cost. Keywords: Electrical- and Mechanical Components, Well field, Engineering, Maintenance.

Question 5

a. (5%) Describe how an electricity tariff (energy price) is determined, based on full development of a geothermal project. Discuss the influential factor on the electricity tariff. Keywords: Cash flow, CAPEX, OPEX Equity, Debt, Lifetime

b, (5%) Describe how a project financial analysis model can be used to estimate potential electricity tariff (energy price) for a geothermal project. Discuss the influential factor on the electricity tariff. Keywords: Cash flow elements, funding, profitability indicators.