1 General overview (15%p)

Please draw an example of a typical Norwegian "mountain hydro power system", name all important components and explain their purpose.

2 Fluid Dynamics (15%p)

2.1 Lumped parameter models

a) Explain the term "lumped parameter model".
b) Give one example of a "lumped parameter".
c) Name *at least* one benefit and one drawback of using a "lumped parameter model" instead of using for example finite element methods.

2.2 Conservation laws

Please write down the formula for the law of energy conservation as applied for the control volume and describe the meaning of all variables in the formula **and their units**.

2.3 Media density

A so-called open container is a very special case when it comes to calculating the pressure and media density of a fluid.

a) What assumption can be made about the media density of a fluid in an open container?
b) Write down the now simplified formula for the calculation of the pressure for open containers.

3 Turbines (15%p)

3.1 Types

Name the three most common turbine types and describe their typical application area based on the water head and water discharge.

3.2 Runner power

a) Please write down the formula for the runner power and explain the meaning of the variables.
b) For which type(s) of turbines can the equation of the runner power be simplified and how?

3.3 Efficiency

a) Please draw a graph comparing qualitatively the efficiency with respect to the discharge ratio for the three turbine types.
b) Give one reason per turbine type which explains its efficiency curve shape.