MEEN 615 600-700 Project

Due Date: 12/01/2025

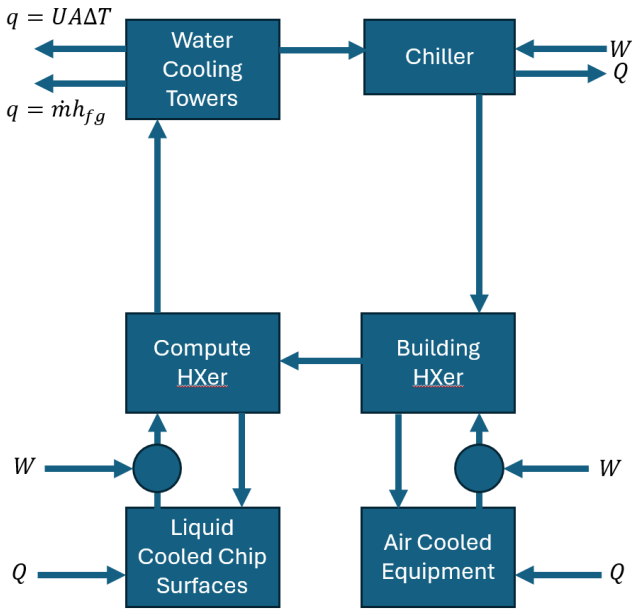
Group Size: 3-4 (teaming can be done on the people page on canvas)

Modern datacenters are some of the biggest heaters humans have ever built, and we are planning to build more heaters than ever before. One new challenge that caught the industry off guard was how quickly we have deployed chips with heat fluxes so high they MUST be liquid cooled (data center managers hate water!). Your task is to design, at the system level, the building cooling system for a modern data center.

Most commercial buildings use a chiller to cool down water and pump it throughout the building. The chiller uses a refrigeration cycle with a compressor, nozzle, evaporator, and condenser to cool the flowing water down to roughly 10 °C. This cooled water then pumps around the building interfacing with other heat exchangers to absorb heat. Because of the high heat capacity of water, chillers typically do not well tolerate large ΔT, and so the water must be precooled before recirculating to the chiller by water cooling towers. A traditional water cooling tower uses primarily transpiration cooling $\dot{m}h_{fg}$ to drop the temperature of the water, and it is this loss of water that has become a significant source of public frustration as it strains existing water supplies.

Your tasks for this project:

1. Develop a system level model of the modern 1 GW AI datacenter cooling architecture, using the following diagram as a guide. Each component should have it's own energy balance between inlet and outlet states, with all variables defined in a list of variables.



2. Make reasonable assumptions about component performance based on publicly available data on commercial equipment. For source of heat, use NVDA GPUs H100 or better, and assume that 90% of overall heat comes from liquid cooled GPUs and the rest is air cooled. Assume the temperature of the water used to cool the chips cannot exceed 40 °C. The air used to cool servers cannot exceed 25 °C (so that humans can work in that environment).

3. Estimate the overall power usage effectiveness (PUE) and water usage effectiveness (WUE) ratios for your datacenter. Comment on the societal implications, if any.

4. Identify at least one component or subsystem that could be substantially optimized, and propose at least one way to do so.

Submit your response to 1-4 in journal paper form.