AMERICAN UNIVERSITY OF BEIRUT

MECH 430 Instrumentation and Measurements

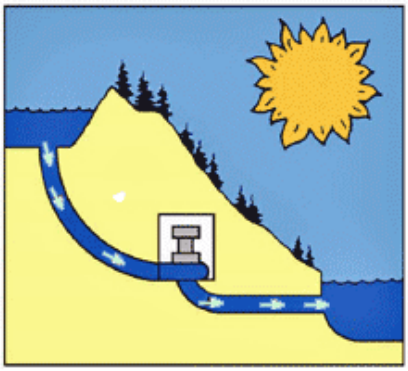
Final Project

Due date: Monday May 1st, 2017

Project details

- Submit the project files on Moodle (report, LabVIEW VIs, etc.) by Monday May 1st 2017 at 23:55PM. All files should be placed in a single folder and zipped. The .zip file should be named by the team members' names.
- Explain everything in order to give you part marks
- The projects can be done in groups of 4.
- This project requires considerable effort so I recommend you start early. You will definitely not be able to complete it in 4 to 5 days.
- Absolutely no extension is possible for this project.
- The project should be demonstrated to the instructors on Tuesday 2nd and Wednesday May 3, 2017. A presentation schedule will be posted on Moodle prior to the presentation days.

Project: Pumping storage Hydroelectricity.



Daytime: Water flows downhill through turbines, producing electricity

Nightime: Water pumped uphill to reservoir for tomorrow's use

The objective of the project is to control a hydro-electric power plant. The plant is used to stock water to generate electricity for the neighborhood city/village.The method of pumping storage consists of storing energy by pumping water from a ***low Level reservoir*** to a higher reservoir at low load peak of the electricity demand. The water discharges from the ***High Level Reservoir*** into a turbine when the demand of the electricity is high. The aim is to maintain the level of water in the ***High Level reservoir*** at a specified set point defined by the operator. The operator shall define 2 levels for the ***High Level reservoir***: an upper threshold and a lower threshold. The pump should start pumping water once the water level in the ***High Level Reservoir*** drops below the lower threshold and fully stops once the level is above the upper threshold. While the pump is operational (between thresholds, the speed at which it is pumping should be controlled according to the level of water in the upper tank based on the following relation:

Output % = 50% + 50*exp(-X/Y)

where: Y = [upper threshold – lower threshold]
X = [upper threshold – current level]

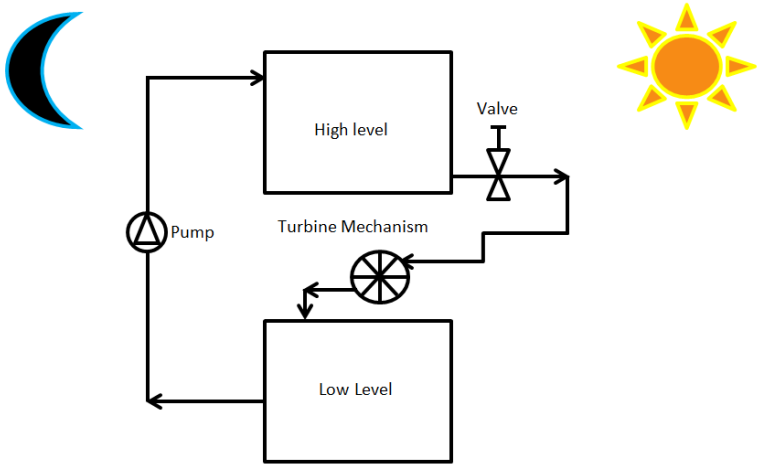


Figure 1 Setup of the system

The requirements of the project:

1- Level measurement of water inside the high level reservoir. (Check appendix below)

2- Pumping: the pump is turned ON/OFF, manually by a physical switch. In addition, the pump should be controlled by the level sensor.

In a real plant, most of the pumping is done by night, because the electricity peak load on the grid is low. Add a light sensor, to switch ON the pump automatically at night, only if the top reservoir is empty.

3- Add 3 LED on the circuit:

- Red turns ON when the system is pumping from the bottom reservoir to the top reservoir.
- Green turns ON, when water is discharged from the top reservoir to the turbine.
- Yellow, warning light, blinks when the top reservoir is empty.

4- Install a manually controlled valve on the top reservoir, which releases the water to turn the turbine. On the bottom of the tunnel connecting the top reservoir to the bottom reservoir, install a wheel (instead of a turbine). The wheel will be rotating as a result of the potential energy of the water. Measure the speed of the wheel and indicate the value with a meter on the Front panel.

5- Add a temperature sensor (Thermocouple or RTD) for the water in the reservoir (only one sensor; to be installed either inside the top reservoir or at the bottom). The value measured is displayed on the Front panel **(the sensor range is between 0 and 50 degrees Celsius)**. You are required to use an instrumentation amplifier to get accurate values. Display on the screen also the following message:

- "Acceptable temperature", when the temperature is between 15 and 25 degrees Celsius.
- "Hot water", above 25 degrees.
- "Freezing water", below 15 degrees.

The system should shutdown when the water is hot or freezing and an alarm buzzer should go off, alerting that the system is down. Add a physical push button to reset the alarm system.

Bonus:

Optional (Bonus if done using Arduino Board)

6- The office of the plant is powered by solar energy. Add a PV cell, with a sun tracking mechanism. The PV cell will track the light by rotating on its axis; the speed of the rotation should be half the speed of the motor. The PV cell should light up one LED.

7- Add a contamination sensor for the water.

8- Install a plastic water solenoid valve, controlled by a manual switch, on the top reservoir, which releases the water to turn the turbine. The valve only opens using the switch, and when the level of the water in the reservoir is higher than half. The valve is closed manually or when the top reservoir is empty.

Notes:
The water level sensor will be a capacitive sensor made of a pair of aluminum foils facing one another and placed around the secondary tank.
The capacitance can be measured by measuring the charge / discharge time of the capacitor and using the relation of the time constant = R*C
Note: The higher the value of the resistor in series with the capacitor the larger the time constant will be for a given value of capacitance.