CSE251 Lab Project Handout - Spring' 23

Automatic Water Level Detection and Control

Background

Overhead water tanks are commonly used to store and supply water for domestic and industrial use. However, manual monitoring and control of the water level in these tanks can be time-consuming and error-prone, and might lead to wastage due to an overflow of the tanks. An automatic water level detection and control system can improve the efficiency and reliability of water supply.

Project Goal

The goal of this project is to design and implement an automatic water level detection and control system for an overhead water tank. The system will use electronic components such as diodes, BJT, MOSFET, and op-amps to sense the water level and control the pump to maintain the water at a desired pre-defined level in the tank. This project will also provide an opportunity to apply principles of electronics and circuit design to solve a real-world problem.

Learning Outcomes

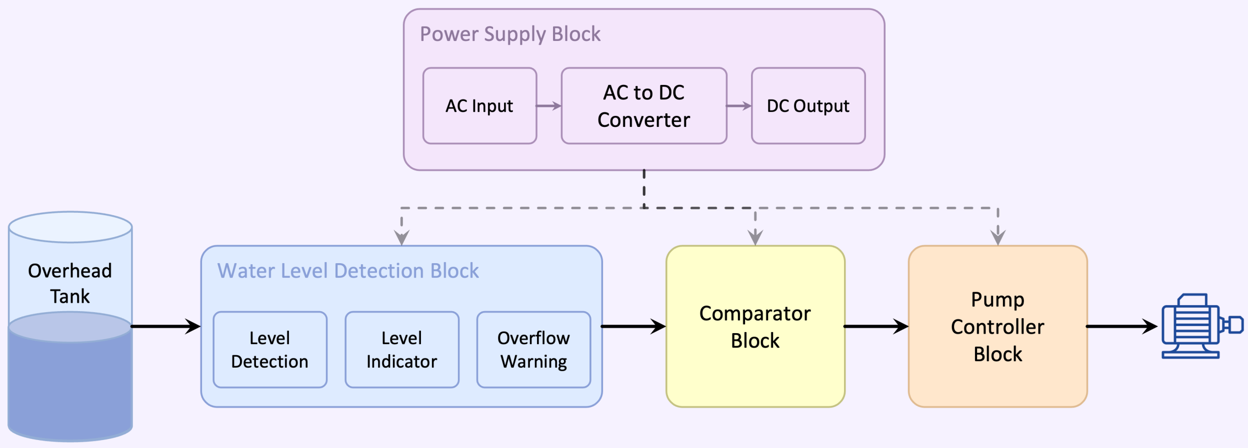
After the project, a student should be able to -

- Understand the principles of basic electronic components
- Learn how to design and implement electronic circuits using diodes, BJT, MOSFET, and op-amps.
- Gain experience in using electronic test equipment such as multimeters.
- Practice problem-solving skills and applying theoretical concepts to a real-world problem.
- Understand the importance of breaking down a problem and testing and debugging the components.
- Learn to work in a team on a project with a defined goal and timeline.

Building Blocks

Like any engineering problem, breaking down the project problem into smaller, more manageable components can make it easier to understand and build. By breaking a complex project into smaller blocks, it becomes possible to focus on specific aspects of the project and develop solutions for that block. This can also help to identify any dependencies or interactions between different blocks, which can be important for understanding the overall project. Additionally, breaking down a project can make it easier to test and debug the project. Your goal in this lab is to make, test, and debug the different blocks of the project as we go along, and submit the final project at the end of the lab.

Project Block Diagram



For this project, we have four main building blocks, as shown in the diagram above. The function of each blocks are explained briefly in the next few subsections.

Power Supply Block

Most electronic components and devices, such as microcontrollers, sensors, and actuators, are designed to operate on DC power. In order to use power from the electrical grid, which is in the form of AC power, to operate electronic components, it needs to be converted from AC to DC using a power supply block. This power supply block serves as a bridge between the AC power source and the DC-powered electronic components, allowing them to function properly. We will use ***Diodes*** to convert from AC to DC.

We could have used DC batteries for the power supply. However, batteries have a limited lifespan and will need to be replaced periodically. Moreover, if the power consumption is high, it is not practical to use batteries as the power source.

Water Level Detection Block

The easiest way to detect water level on a tank is to place probes at different levels of the tank and use bipolar junction transistors (***BJT***s) to sense the current at each probe. As the water level changes, the probes will be submerged one by one, which will create a small current at the probes. The BJTs can amplify this current and turn on a LED. The LEDs can be connected to the circuit in such a way that they turn on when the water level reaches a certain threshold, thus providing a visual indication of the water level. We can use different colored LEDs can be used to indicate low, medium, and high water levels. In additiona, we can add a buzzer (operated using another BJT) that will notify us about the potential overflow of water.

Comparator Block

This block will compare the water level to pre-determined thresholds to detect whether the tank is full or empty and when to turn off/on the pump. If the tank is full, it will turn of the water pump. If the tank is empty, it will turn off the pump. We can use operational amplifiers (***Op-Amps***) to make this comparison block.

Pump Controller Block

Our system has a pump that will supply water to the tank. Pumps require high amount of current which cannot be provided by the comparator block. So a device is needed that can provide high amount of current and turn on or off the pump based on the output of the comparator block. The pump controller block will use ***MOSFET*** in it which will act as a switch to turn on/off the pump.

Lab and Project Timeline

Lab No.	**Experiment Date**	**Lab Title**
Lab 1	Tue, Jan 31	Study of Op-Amp Comparator, Inverting Amplifier, Non-Inverting Amplifier
Lab 2	Tue, Feb 7	Study of Op-Amp Inverting Summing Amplifier, Schmitt Trigger and Project Milestone-1
Lab 3	Tue, Feb 14	Study of IV Characteristics of Diode and Zener Diode
Lab 4	Tue, Feb 28	Study of Half-Wave (HW) and Full-Wave (FW) Rectifiers
Lab 5	Tue, Mar 14	Study of Voltage Regulator and Project Milestone-2
Lab Test	Tue, Mar 21	Syllabus: Lab 1, 2, 3, 4, 5
Lab 6	Tue, Mar 28	Study of IV Characteristics of MOSFET and Design Logic Gates using MOSFET
Lab 7	Tue, Apr 4	Study of IV Characteristics of BJT and Common Emitter Amplifier
Project Update	Tue, Apr 11	Project Milestone-3
Project Submission	Tue, Apr 18	**Final Project submission**

CSE251 Lab Policy - Spring' 23

Marks Distribution

Attendance	Report	Lab Test	Project	Total
4%	4%	7%	10%	25%

Note that ***Attendance*** includes lab performance marks.

Lab Group

There will be ***4 students per group***. At max one group can have 5 members.

Attendance Policy

- ***Attendance*** will be counted in the following ***4 categories***:
  - Present (P) / Absent (A) / Late (L) / Excused absent (E)
  - 2 Lates = 1 Absent = 0.5 marks penalty of total attendance marks
  - **1 absent** and **1 late** will be excused without any penalty
  - Excused absents must be backed by relevant documents (e.g. medical reports)
- ***Lab performance*** marks will be awarded based on the performance of the group.
  - For late (L), lab performance marks will be 50% of the group's mark for that experiment
  - For absent (A), lab performance marks will be zero (0) for that experiment

Lab Report

At least ***one student*** from each group should submit the lab report each experiment. At the end of the semester, each student must submit ***two reports*** in total.

Lab Test

A hardware lab test will be held based on lab 1 to 5. Attending the lab test is **mandatory** to get a passing grade in lab. During the test, a student will be given one experiment randomly. The student need to (1) draw the circuit of the experiment, (2) construct the circuit on the breadboard, (3) take measurements or show the output on oscilloscope, and (4) answer some simple viva questions from the lab sheets.

Lab Project

The lab project marks will be based on the overall completion status of the project as well as individual contribution.