Oakland University
School of Electrical & Computer Engineering
Winter 2023
ECE 4721/5721
Professor Phares Noel, Ph.D., PE
Lab #2
Due on 02/23/2022
Laboratory located in EC 461

The use of Audio output and GPIO output

The purpose of this lab is for you to develop and demonstrate C-Programs that will execute on the FRDM-KL25Z Embedded System Development Board that will perform the following operations. Submit a copy of your fully commented Program listing of your final designs. Please adhere to the Lab Submittal Guidelines.

Part 1 - (40 Points)

Refer to Figure 2.14 on page 43 of the A.G. Dean text book. Use the Listing 2.5 (or your own C code) to generate a digital output. Connect an Audio Speaker to any output Port of the development board with a Resistor and Capacitor with the values as shown in Figure 2.14. Vary the delay to hear the difference in the sound that's produced.

Part 2 (40 Points)

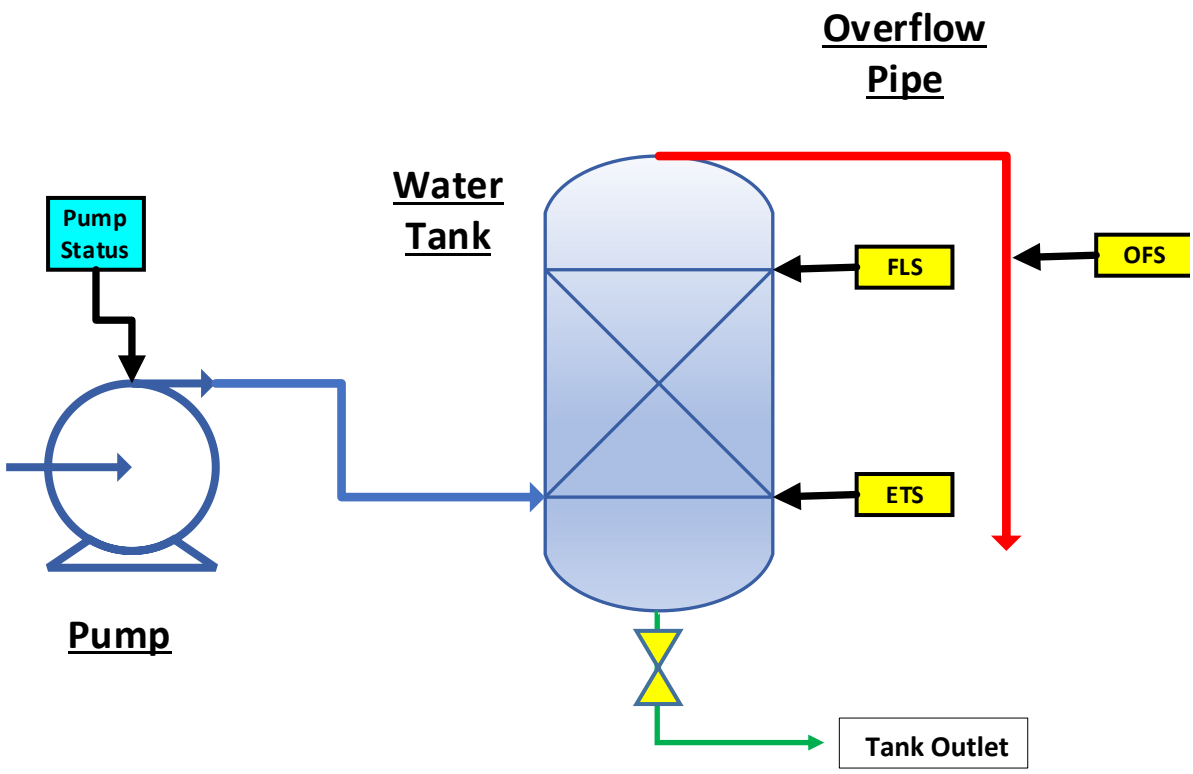
Apply the knowledge gained about GPIO, to solve a design problem. Use the Finite State Machine (FSM) concept in the design and implementation of your program to control the system.

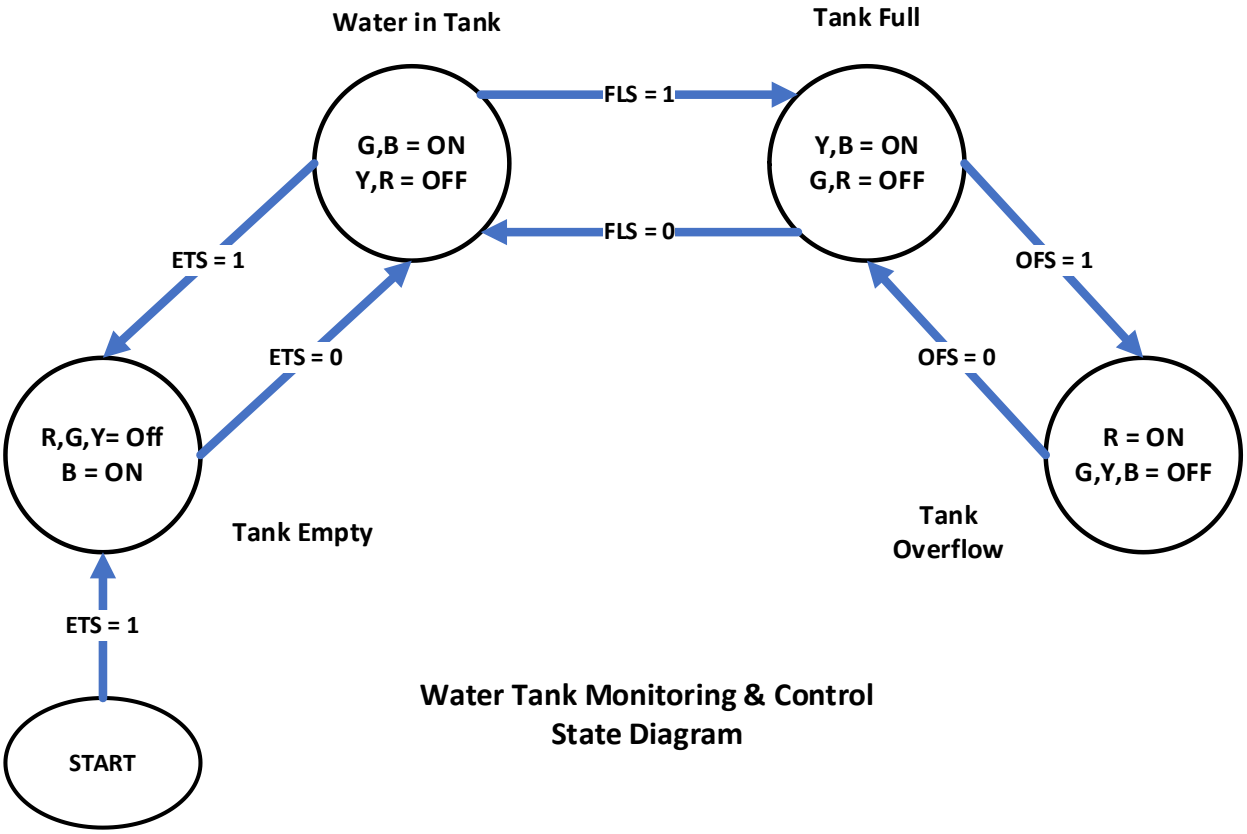
There is a need to design a system that will monitor the level in a Water Tank. A State Diagram has been provided for you to describe the operation of the proposed system.

There are level sensors, indicator lights and a control signal that monitor and control the level in the water tank. The following are the labels that are used in the State Diagram for the sensors and lights:

Sensor Descriptions

- ETS = Empty Tank Sensor
- FLS = Full Tank Level Sensor
- OFS = Over Flow sensor
- G = GREEN LED – Water in Tank
- R = RED LED – Tank Overflow
- Y = YELLOW LED – Tank Full
- B = Blue LED (Pump Signal)





Water Tank Monitoring & Control
State Diagram

There is also a an electronic signal that controls the water pump. It's status is designated by a BLUE LED

1) At the beginning, the Tank is empty and the Pump is signaled to start. At this point all the Tank Level LED's are OFF and the pump run signal is on indicated by the BLUE LED being ON.

2) Once water starts entering the tank, at a certain point the GREEN LED is turned on and the RED & YELLOW LED's are off indicating that there is water in the tank and the pump is still needed.

3) As the tank begins to fill, at some point the water level may activate the Full level Sensor (FLS = 1). At that point turn ON the YELLOW LED and turn OFF the Green & RED LED's.

4) If the water usage is more than is supplied by the pump, then the water level may drop down below the Full Level (FLS=0). At that point turn OFF the YELLOW & RED LED's and Turn ON GREEN LED.

5) If the water usage continues at this rate, then the Tank will become empty and the Empty Tank Sensor is activated (ETS=1) indicating that there is no water inside tank. At this point the GREEN, YELLOW & RED LED are all OFF and the BLUE LED is ON indicating the pump is still needed.

Do not use the on board integrated LED. Connect the GREEN, RED, YELLOW and Blue LEDs to output port. Connect a switch to input port to indicate the two water levels ETS and FLS.

Part 3 - (20 Points)

Add another sensor and call it the Over Flow sensor (OFS). If the tank is full and the pump is still running, then the water level may rise in the tank above the Full Level. At some point the water level may become high enough where the water will begin to flow into the overflow pipe, which is there to prevent damage to the water tank.

Water flowing in the overflow pipe will activate the Overflow Sensor (OFS=1) which will then turn ON the RED LED and turn OFF the YELLOW & GREEN LED's and also turn OFF the Pump (Blue LED).

If the overflow stops; which should happen when the pump stops running and the water usage continues, then turn OFF the RED LED, turn ON the Blue LED (signaling to turn on the pump) and turn ON the GREEN or YELLOW depending on the FLS state.

Grading Rubric

Note: *Submission must have mandatory Title Page with Name/Date, etc. per syllabus.* ***5 points*** *will be deducted from final score if not present in submission.*

Part 1, Speaker (40 points)

20 points - Video demonstration of part 1 showing the speaker running (submitted along with report)
8 points - Description of experiment
4 points - Full source code in report
4 points - Hardware Description (I/O pins used, external components, etc.)
4 points – Flow diagram explaining your implementation

Part 2, Three State FSM (40 points)

20 points - Video demonstration of part 2 showing proper transitions between all states (submitted along with report)
8 points - Description of experiment
4 points - Full source code in report
4 points - Hardware Description (I/O pins used, external components, etc.)
4 points – Flow diagram explaining your implementation

Part 3, Four State FSM (20 points)

10 points - Video demonstration of part 3 showing proper transitions between all states (submitted along with report)
4 points - Description of experiment
2 points - Full source code in report
2 points - Hardware Description (I/O pins used, external components, etc.)
2 points – Flow diagram explaining your implementation

EXAMPLE TITLE PAGE FOR LAB & HOMEWORK SUBMISSIONS

Oakland University
School of Electrical & Computer Engineering
Winter 2023
ECE 4721/5721
Embedded System Design

Title of

Lab Report
&/or
Homework Submissions

Student First & Last Name
Date of Submission