

## Problem Set #3, EE part

Issue date: Oct. 27, 2021; Deadline: 23:59, Nov. 10, 2021

Student Name: \_\_\_\_\_ Student No.: \_\_\_\_\_

### 1. FSM I

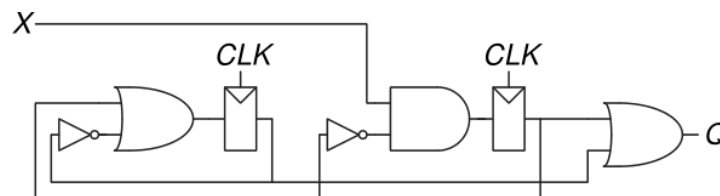
- Implement the traffic light example finite state machine, which was introduced in lecture, with Multisim (use the digital clock component in Multisim to generate clock ticks). Change the output encoding into one-hot encoding as follows, and use the red, green, yellow indicating lights to show the result. (20')

Output	Encoding L2:0
green	001
yellow	010
red	100

- In the real scenario, the lights might be controlled according to time rather than sensors. Design the time-based traffic light, for example: green 27 sec, yellow 3 sec, red 30 sec. (20')

### 2. FSM II

- Analyze the FSM shown as follows. Write the state transition and output tables and sketch the state transition diagram. If CLK is a 10 Hz square wave, what's the output waveform when X=0? What's the output waveform when X=1? (20')



### 3. 2 bits easy ALU

Implement a 4 bits adder using the basic logic gate (NOT, AND, OR, NOR, NAND, etc.) with multisim. The ALU pins include: four input bits X1, X0 and Y1, Y0; two output bits Z1, Z0; one carry bit C; one control bit Ctrl. (25')

- Each ALU implements one arithmetic and one logic functions, according to the last digit of your student number.

Last digit	Function
0, 1	Addition ( <b>ctrl=0</b> ) & AND ( <b>ctrl=1</b> )
2, 3	Addition ( <b>ctrl=0</b> ) & OR ( <b>ctrl=1</b> )
4, 5	Addition ( <b>ctrl=0</b> ) & XOR ( <b>ctrl=1</b> )
6, 7	Addition ( <b>ctrl=0</b> ) & NAND ( <b>ctrl=1</b> )
8, 9	Addition ( <b>ctrl=0</b> ) & NOR ( <b>ctrl=1</b> )

( For example: If the last digit of your number is 0, then when Ctrl=1, Z0 = X0 AND Y0, Z1 = X1 AND Y1. )

#### 4. MCU development

- Using a potentiometer and esp32 board, control the brightness of one led by adjusting the potentiometer. (15')

(It is recommended that using the AD and PWM functions of esp32.)

(Annotate each line of your code and take a clear picture. In addition, take a clear picture of the hardware connection part. Make sure your student ID card is shown in two pictures.)

(Make sure you submit your code in addition to two pictures.)

#### **Bonus question (10')**

- Using a potentiometer to control the frequency of breathing led (呼吸灯).

(The full score of this homework assignment is capped at 100 points.)

*\* When capturing circuit schematics and simulation results, taking a screenshot is recommended. Please refrain from using your phones to take a photo of the screen.*

*\* Please submit the softcopy of your solutions to the problems on gradescope. When uploading to gradescope, please select all corresponding pages related to each question.*

*\* Please use English.*

*\* All flow charts and codes should be enclosed in your solutions.*

*\* Discussion on methodology is allowed, yet, the assignment should be done individually. Plagiarism, once found, grades zero for the whole homework assignment!!*