

Problem Set #2, EE part

Issue date: Oct. 8, 2021; Deadline: 23:59, Oct. 15, 2021

Student Name: _____ Student No.: _____

1. CMOS logic gate

Use the fundamental CMOS logic circuit units, NAND and NOT, to build a XOR gate

- Truth table and logic circuit (gate level) design. (10')
- CMOS-level implementation (15')
- Measurement results (5')

2. Combinational logic circuit exercises

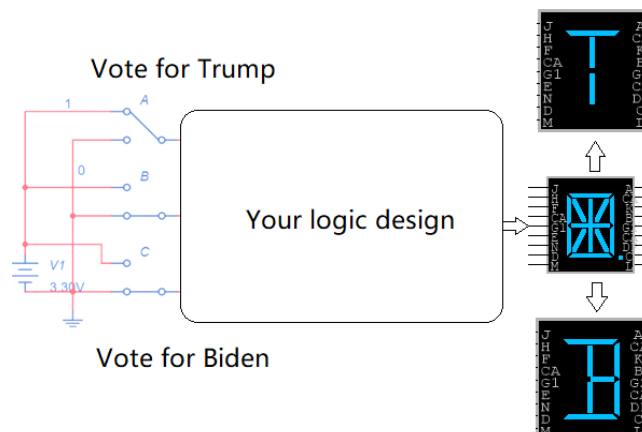
- Write the Boolean equations in sum-of-products canonical form for each of the truth tables (1' * 5)
- Simplify the logic using the K-map (2' * 5)
- Implement the circuits in Multisim and test their performance (2' * 5)

(a)	(b)	(c)	(d)	(e)
A B Y	A B C Y	A B C Y	A B C D Y	A B C D Y
0 0 1	0 0 0 1	0 0 0 1	0 0 0 0 1	0 0 0 0 1
0 1 0	0 0 1 0	0 0 1 0	0 0 0 1 1	0 0 0 1 0
1 0 1	0 1 0 0	0 1 0 1	0 0 1 0 1	0 0 1 0 0
1 1 1	0 1 1 0	0 1 1 0	0 0 1 1 1	0 0 1 1 1
	1 0 0 0	1 0 0 1	0 1 0 0 0	0 1 0 0 0
	1 0 1 0	1 0 1 1	0 1 0 1 0	0 1 0 1 1
	1 1 0 0	1 1 0 0	0 1 1 0 0	0 1 1 0 1
	1 1 1 1	1 1 1 1	0 1 1 1 0	0 1 1 1 0
			1 0 0 0 1	1 0 0 0 0
			1 0 0 1 0	1 0 0 1 1
			1 0 1 0 1	1 0 1 0 1
			1 0 1 1 0	1 0 1 1 0
			1 1 0 0 0	1 1 0 0 1
			1 1 0 1 0	1 1 0 1 0
			1 1 1 0 1	1 1 1 0 0
			1 1 1 1 0	1 1 1 1 1

3. Majority voting and 14-segment display

Referring to the majority voting system introduced in the lecture, design a logic circuit with Multisim and show the voting result with a 14-segment display as follows (T for Trump and B for Biden).

- Show the design procedures and final circuit schematic. (15')
- Show the result pictures of eight input conditions. (5')



4. MCU development

- Using the AD (analog to digital) and DA (digital to analog) functions of esp32 to measure the I-V characteristics of a diode (apply different voltage across the diode and measure the current through the diode with a sampling resistor). Mark down the data and draw the I-V curve of the diode. (25')
(Use your esp32 development board. Because the ad port of esp32 can only recognize the voltage input, a small resistance is used to measure the voltage and obtain the circuit current; the circuit voltage is provided by the DA port of esp32; the DA voltage should be evenly increased from 0 to 3.3V, and the interval should be arranged by yourself. The more sampling points, the closer the curve is to the ideal.)
(Annotate each line of your code and take a clear picture. In addition, take a clear picture of the result curve in Excel. Make sure your student ID card is shown in two pictures.)
(Make sure you submit your code in addition to two pictures. The code should be able to be copied and pasted)
(You can refer to the assignment guide in piazza for more information on how to program your esp32)

Bonus question

- Using the AD and DA functions of esp32, measure the response of an NPN BJT (bipolar junction transistor) under different applied voltages. Draw the output characteristic curve of the BJT with the acquired data. The other requirements are the same as those in question 4. (10')
(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!!*