Laboratory Assignment 3: Integrated Circuit Digital Logic Gates

ECE 0201: Digital Circuits and Systems

45 Points

Name

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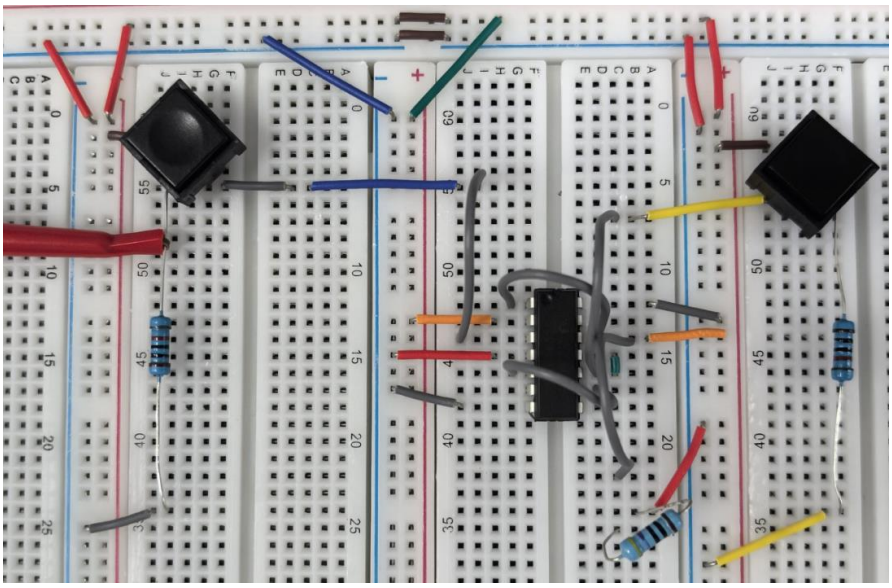
Submission Checklist:

- ☐ Write within boxes, do not move boxes
- ☐ Write your full name in the box above
- ☐ Save this file as a PDF before uploading, keep the number of pages (**9**) unchanged
- ☐ Note “TO BE CONTINUED” in the answer box if you used the extra pages (7-9)

Part I: Integrated Circuits (9 points)

2-input NAND gate using CD4007

[(A) Insert a picture of your build of the circuit in Figure 5] (2 points)



[(B) Fill out the following information] (4 points)

S1 (A)	S2 (B)	V_A	V_B	V_{Out}	LED (on/off)
Open	Open	-0.005mV	0.2675mV	4.9989V	ON
Open	Closed	0.001mV	4.9989V	4.9989V	ON
Closed	Open	4.9986V	0.0769mV	4.9987V	ON
Closed	Closed	4.9985V	4.9985V	0.891mV	OFF

[(C) Select a logic abstraction, draw a truth table for the inputs and outputs] (3 points)

Logic abstraction: NAND gate

Input for switches: open is 0, closed is 1

Output for LED: ON is 1, OFF is 0

The chart shows that the output is 0 only if two switches are closed, which can be regarded as NAND logic gate.

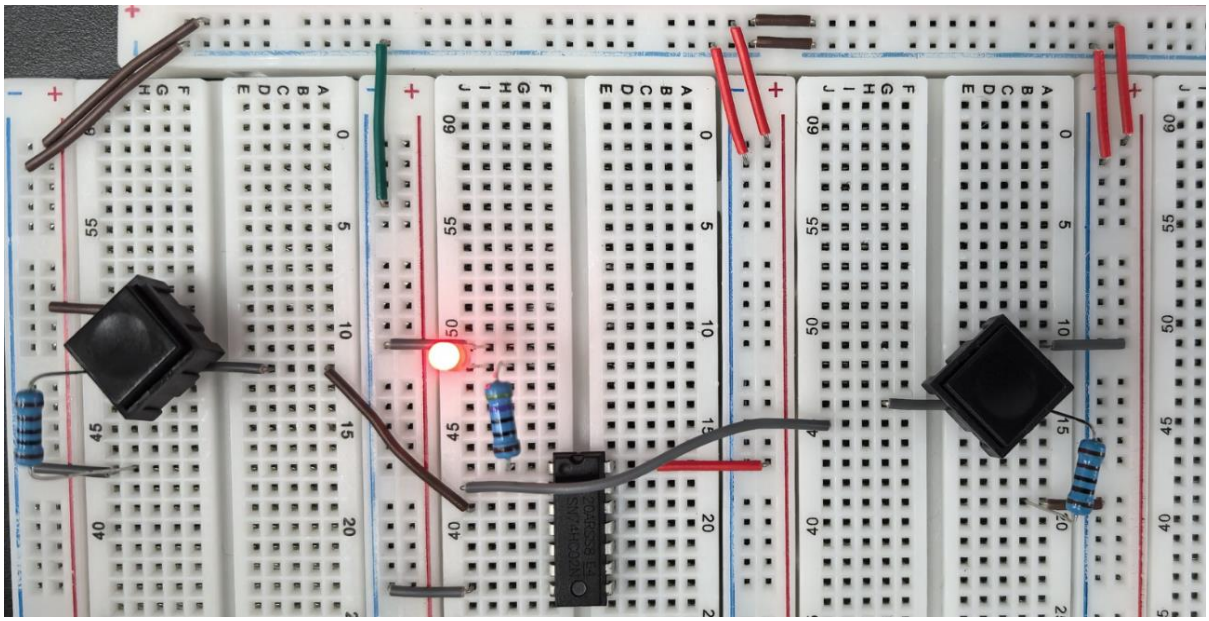
S1	S2	Result
0	0	1
0	1	1
1	0	1
1	1	0

Part II: 7400-Series Logic C (10 points)

[(A) Fill out the following information] (2 points)

Number of transistors in the 7402: 16

[(B) Insert a picture of your circuit] (2 points)



[(C) Fill out the following table] (4 points)

S1	S2	V_A	V_B	V_{Out}
Open	Open	8.720mV	8.204mV	4.9987V
Open	Closed	0.456mV	4.9978V	5.070mV
Closed	Open	4.9978V	0.049mV	2.448mV
Closed	Closed	4.9978V	4.9976V	0.299mV

[(D) Draw a truth table for the gate] (2 points)

Logic abstraction: NOR gate

Input for switches: open is 0, closed is 1

Output for LED: ON is 1, OFF is 0

The chart shows that the output is 1 only if two switches are open, which can be regarded as NOR logic gate.

S1	S2	Result
0	0	1
0	1	0
1	0	0
1	1	0

Part III: Design of an Exclusive-OR Circuit (26 points)

[(A) Draw a truth table for a 2-input exclusive-OR (XOR) gate] (2 points)

Input for switches: open is 0, closed is 1

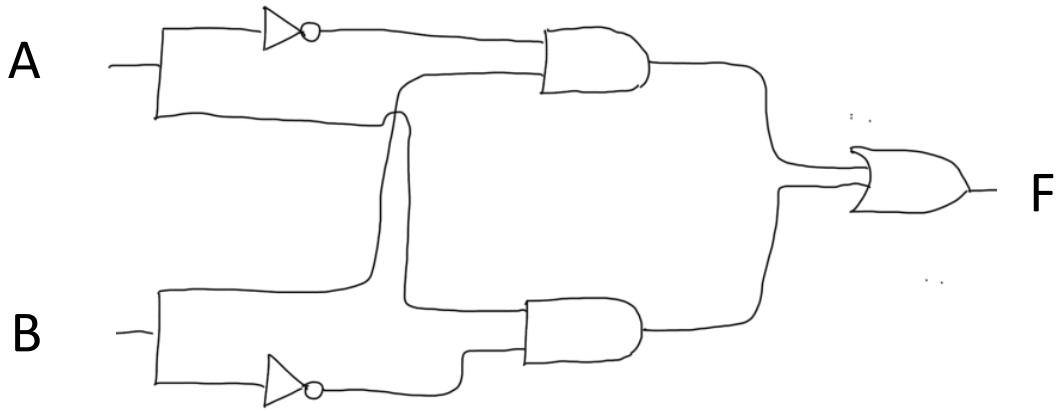
Output for LED: ON is 1, OFF is 0

S1	S2	Result
0	0	0
0	1	1
1	0	1
1	1	0

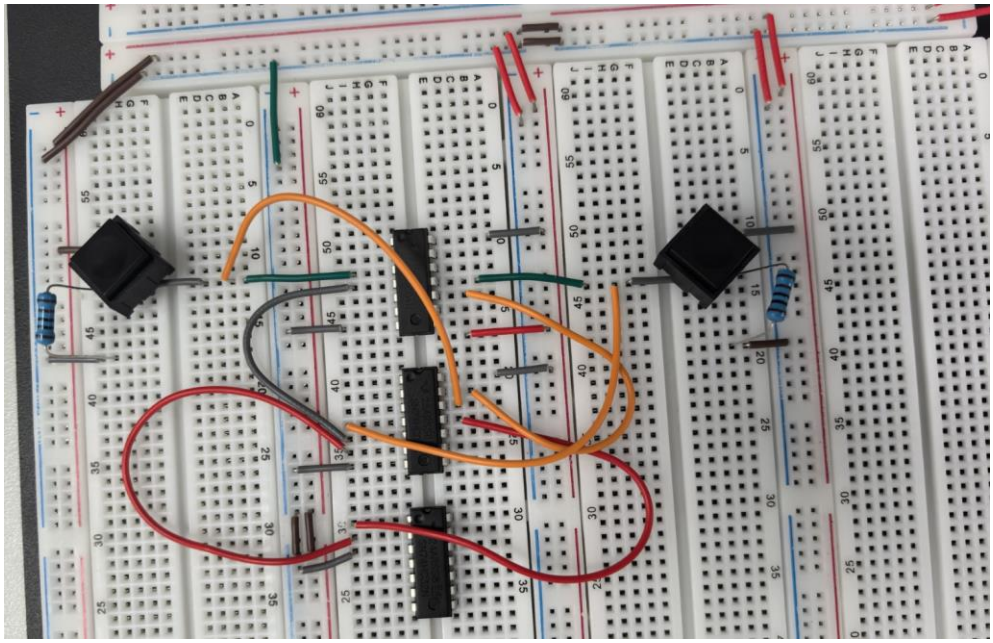
[(B) Write a logic function that represents the exclusive-OR operation] (2 points)

$$A \oplus B = (A\bar{B}) + (\bar{A}B)$$

[(C) Draw a circuit that implements your logic function for the exclusive-OR operation] (2 points)



[(D) Insert a picture of your circuit] (2 points)



[(E) Fill out the following table] (4 points)

S1	S2	V_A	V_B	V_{Out}	LED (on/off)
Open	Open	0.007mV	0.006mV	3.753mV	OFF
Open	Closed	1.626mV	4.9941V	4.5053V	ON
Closed	Open	4.9932V	0.534mV	4.5071V	ON
Closed	Closed	4.9972V	4.9973V	4.967mV	OFF

[(F) Draw a truth table of your circuit] (2 points)

Input for switches: open is 0, closed is 1

Output for LED: ON is 1, OFF is 0

S1	S2	Result
0	0	0
0	1	1
1	0	1
1	1	0

The chart indicates that the output is 1 when two input are different.

[(G) Demonstrate constructed circuit to TA for check-off] (12 points)

EXTRA PAGES

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