KAZAKH BRITISH TECHNICAL UNIVERSITY

School of Information Technology and Engineering

Laboratory work 3
Logic gates

Done by: **Sagingaly Meldeshuly**
Checked by: **Syed Shah**

Almaty 2024

Aims:
define what logic gates are realized schematically, learn the gates' properties. Compare experimental results with theoretical foundations about logic gates.

Practice task:
Preparation to lab work

1. Learn the information about logic gates and integrated circuits (IC).

2. Show truth table of AND, OR, NOT, NAND, NOR, XOR, XNOR, buffer gates.

3. Consider experiments' schemes and draw them with application of Scheme Design.

4. Design XNOR gate for the experiment 3D on the basis of schemes in experiment 3A, 3B, 3C. Draw the XNOR scheme with application of Scheme Design System.

5. Answer the questions below in written form.

5.1 What logical operations do you know?

5.2 Show the algebraic expression of logical operation NOT (AND, OR and so on).

5.3 How many magnitudes has the logic value got?

5.4 What is integrated circuit (IC)?

5.5 What types of IC's do you know?

5.6 What scales of IC's integration do you know?

5.7 How many functions of 2 variables do you know?

5.8 Show the difference between complement and dual functions.

5.9 What function is called odd (even)?

5.10 What IC digital logic families do you know?

5.11 What is positive (negative) logic?

5.12 What are typical voltage levels for TTL, ECL, CMOS families?

5.13 What is fan-out, power dissipation, propagation delay, noise margin?

Consider experiments' schemes and draw them with the application of Scheme Design.

5.1 What logical operations do you know? Logical operations include AND, OR, NOT, NAND, NOR, XOR, XNOR, among others.

5.2 Show the algebraic expression of logical operation NOT (AND, OR, and so on).

NOT: A'
AND: AB
OR: A + B
NAND: (AB)'
NOR: (A + B)'
XOR: A B
XNOR: (A B)'

5.3 How many magnitudes has the logic value got? Logic values have two magnitudes: 0 (False or Low) and 1 (True or High).

5.4 What is an integrated circuit (IC)? An integrated circuit (IC) is a miniature electronic circuit containing many interconnected semiconductor devices, such as transistors, resistors, and capacitors, manufactured on a single semiconductor substrate.

5.5 What types of ICs do you know? Types of ICs include digital ICs, analog ICs, linear ICs, and mixed-signal ICs.

5.6 What scales of ICs integration do you know? IC integration scales include SSI (Small-Scale Integration), MSI (Medium-Scale Integration), LSI (Large-Scale Integration), VLSI (Very Large-Scale Integration), and ULSI (Ultra Large-Scale Integration).

5.7 Show the difference between complement and dual functions. Complement functions are obtained by replacing each variable with its complement and interchanging ANDs with ORs, and vice versa. Dual functions are obtained by interchanging ANDs with ORs, and vice versa, without complementing the variables.

5.8 What function is called odd (even)? An odd function is one that

evaluates to 1 for an odd number of input combinations. An even function is one that evaluates to 1 for an even number of input combinations.

5.9 What IC digital logic families do you know? Common IC digital logic families include TTL (Transistor-Transistor Logic), CMOS (Complementary Metal-Oxide-Semiconductor), ECL (Emitter-Coupled Logic), and others.

5.10 What is positive (negative) logic? - Positive logic defines logic levels where a high voltage represents true or 1, and a low voltage represents false or 0. - Negative logic defines logic levels where a low voltage represents true or 1, and a high voltage represents false or 0.

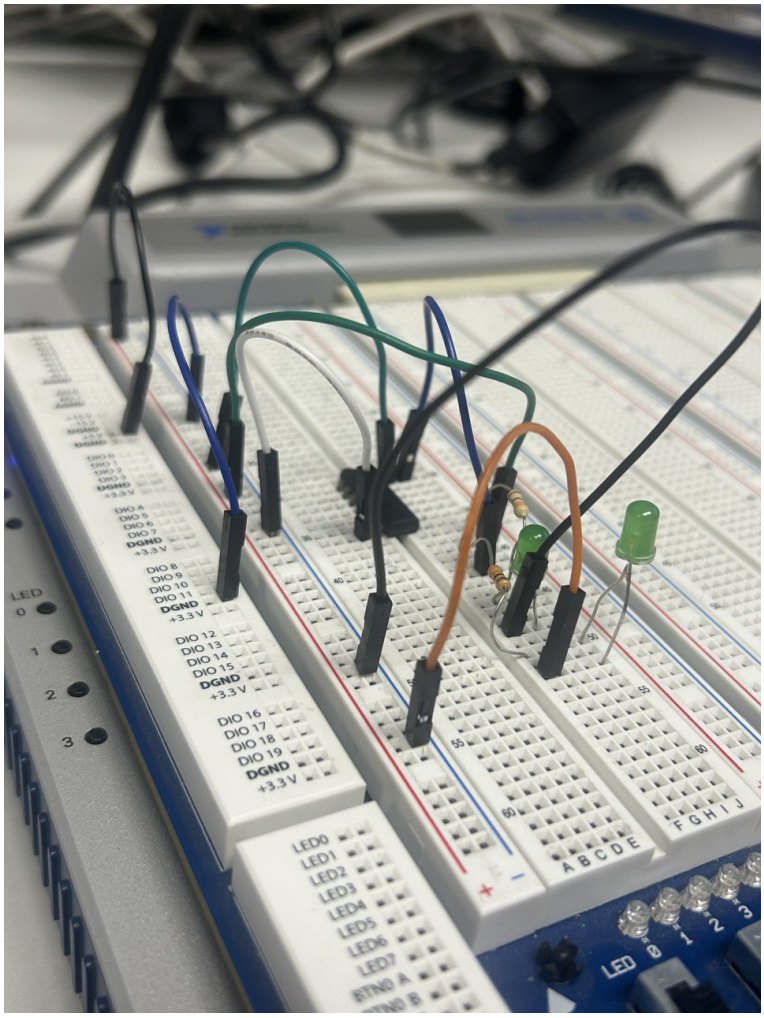
5.11 What are typical voltage levels for TTL, ECL, CMOS families? - TTL: High voltage (logic 1) typically ranges from 2.4V to 5V, and low voltage (logic 0) ranges from 0V to 0.8V. - ECL: High voltage (logic 1) is typically around -0.8V, and low voltage (logic 0) is typically around -1.6V. - CMOS: High voltage (logic 1) is close to the supply voltage (VDD), and low voltage (logic 0) is close to ground (0V).

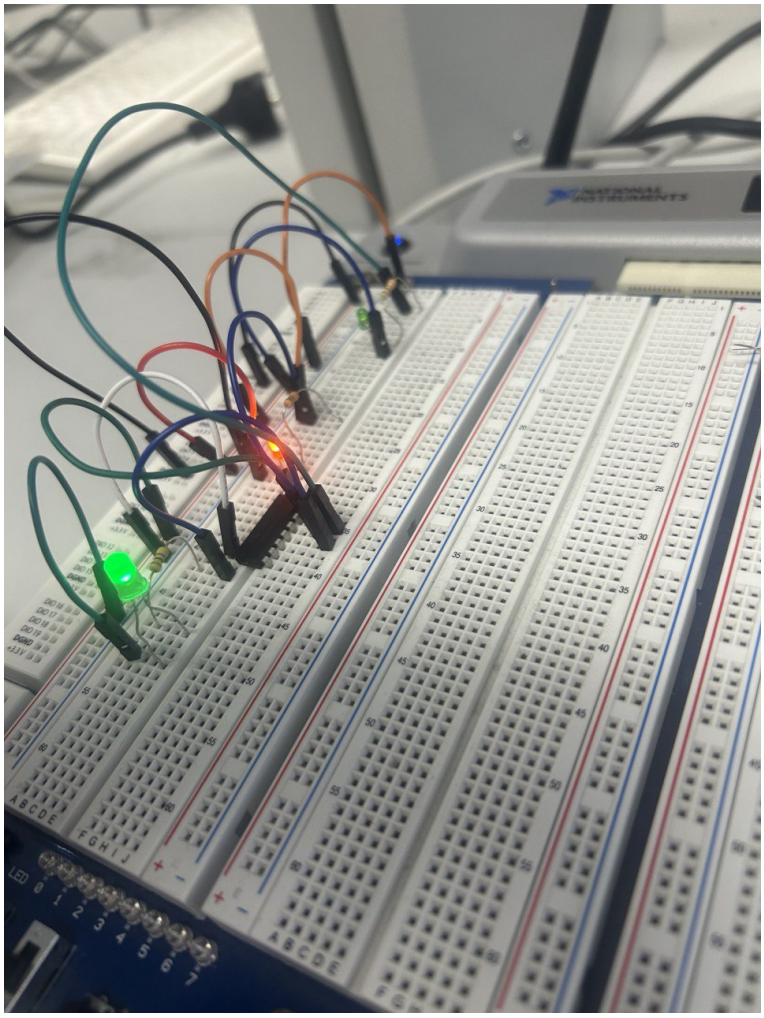
5.12 What is fan-out, power dissipation, propagation delay, noise margin? - Fan-out refers to the maximum number of standard loads (inputs) that an output of a gate can drive without adversely affecting its performance. - Power dissipation is the amount of power consumed by a device or circuit. - Propagation delay is the time taken for a signal to travel from the input of a gate.

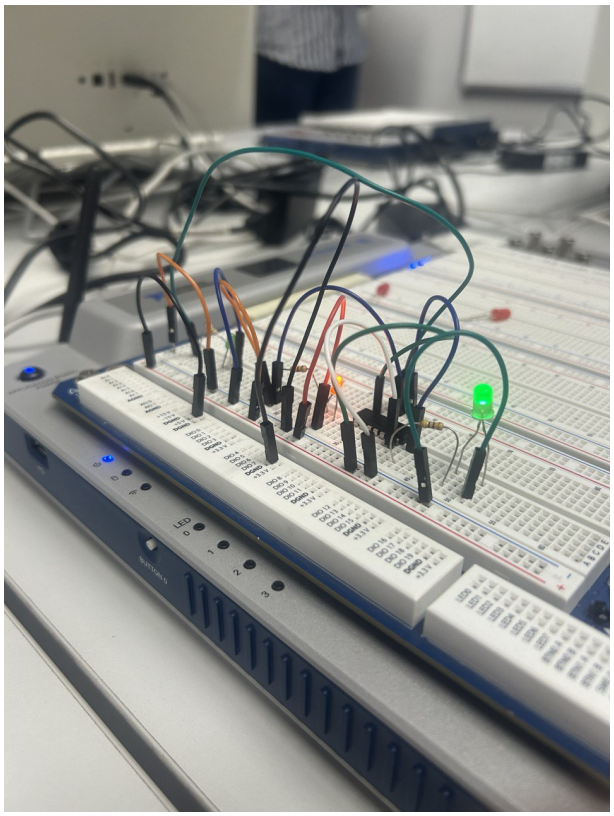
LAB WORK PERFORMANCE

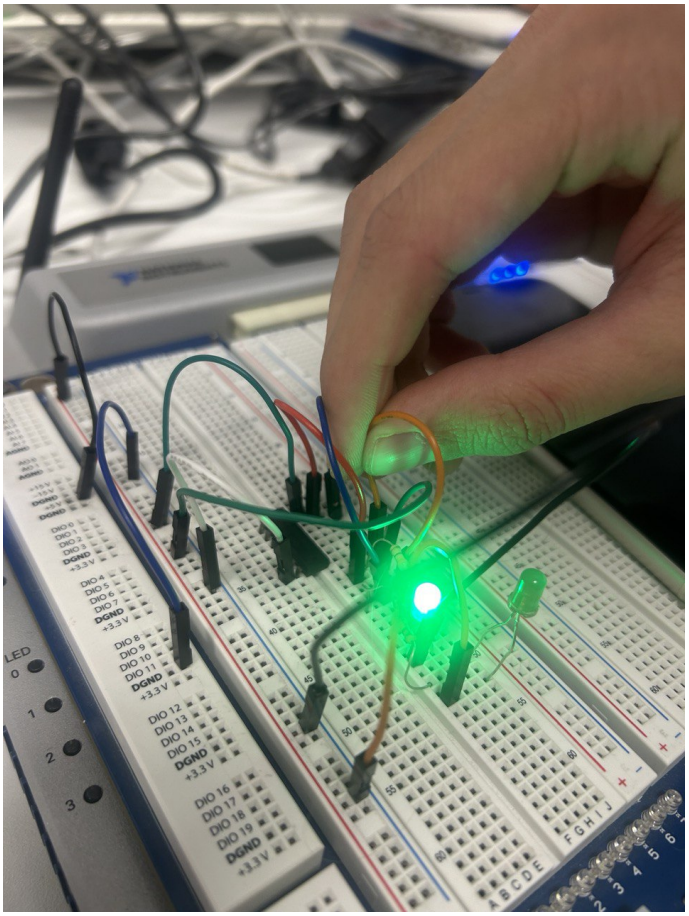
Demonstrate presence of your home preparation for lab work to your instructor.

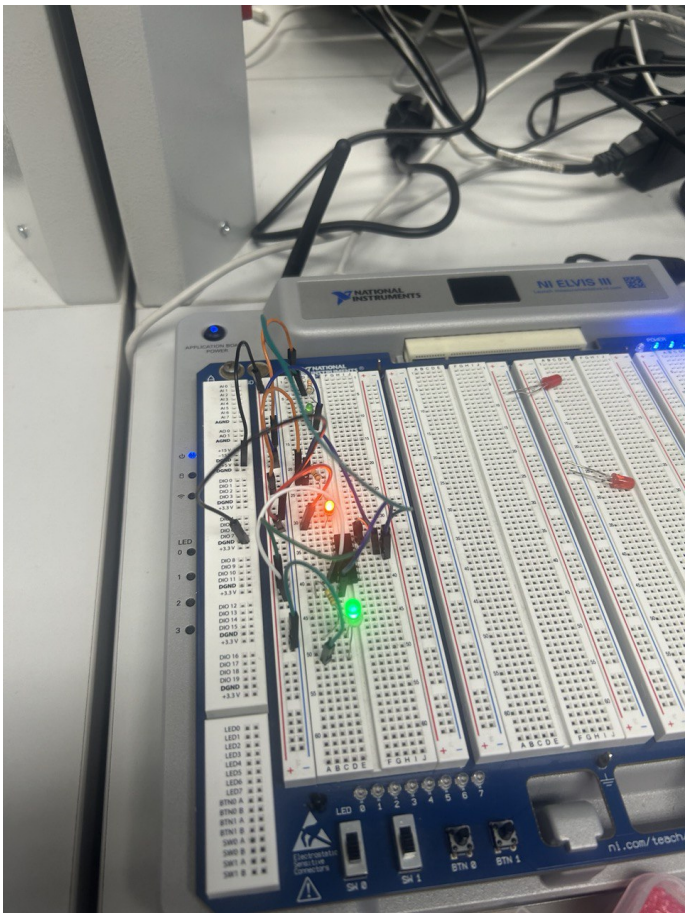
1. Pass test of 10 questions.
2. Get a permission to begin the work.
3. Mount the scheme of experiment 3A on the breadboard and perform it.
4. Make a conclusion about functionality of the scheme. Compare your results with theoretical ones.
5. Demonstrate your results to your instructor. If your results are correct you may dismount your scheme, if no – find the mistake.
6. Repeat steps 4 to 6 for experiment 3B, 3C, 3D.
7. Be ready to answer your instructor's questions in process of work.
8. Complete your work, dismount your schemes, clean your working place.
9. Answer your instructor's final questions, obtain your mark.
10. Ask your instructor's permission to leave.


LED
0
1
2
3
DIO 4
DIO 5
DIO 6
DIO 7
DGND
+3.3V
DIO 8
DIO 9
DIO 10
DIO 11
DGND
+3.3V
DIO 12
DIO 13
DIO 14
DIO 15
DGND
+3.3V
DIO 16
DIO 17
DIO 18
DIO 19
DGND
+3.3V
LED0
LED1
LED2
LED3
LED4
LED5
LED6
LED7
BTN0 A
BTN0 B
A B C D E
F G H I J
LED 0 1 2 3








NI ELVIS III

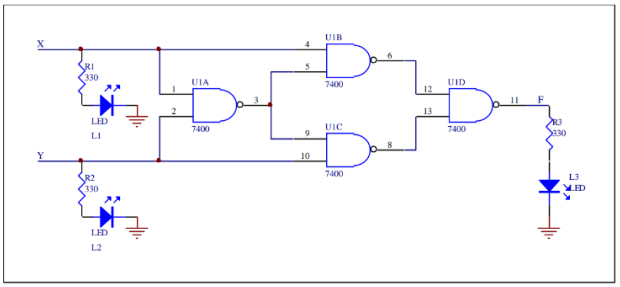


Table 1: AND

	Input	Input	Output	Output
	A	B	LED	V_out
1	0v	0v	0v	1.777nv
2	0v	5v	5v	-6.704
3	5v	0v	0v	3.066v
4	5v	5v	5v	0.278v

TEST QUESTIONS

1. Function # _____ corresponds to function AND of 3 variables.

X	Y	Z	F_1	F_2	F_3	F_4	F_5
0	0	0	0	0	0	0	0
0	0	1	0	0	1	1	0
0	1	0	0	0	1	1	0
0	1	1	1	1	1	1	0
1	0	0	0	1	1	1	0
1	0	1	1	1	1	0	0
1	1	0	1	1	1	0	0
1	1	1	1	1	1	1	1

A. 1 B. 2 C. 3 D. 4 E. 5

2. The truth table for XOR gate is:

A			B			C			D			E		
X	Y	F	X	Y	F	X	Y	F	X	Y	F	X	Y	F
0	0	0	0	0	0	0	0	1	0	0	1	0	0	0
0	1	0	0	1	1	0	1	1	0	1	0	0	1	1
1	0	0	1	0	1	1	0	1	1	0	0	1	0	1
1	1	1	1	1	1	1	1	0	1	1	0	1	1	0

3.A small-scale integration (SSI) device contains _____ gates in a single chip.
A. thousands of B. From10 to 1000 C. More than 100
D. From 10 to 100 E. less than 10

4. (XY)´ is algebraic expression of _____ function.
A. XOR B. XNOR C. NOR D. NAND E. AND

5. NOR is dual to A. XOR B. XNOR C. NOR D. NAND E. AND

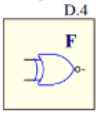
6. OR is complement to A. XOR B. XNOR C. NOR D. NAND E. AND

7. A buffer produces the _____ function.
A. complement B.dual C. transfer D. inhibition E. implication

8. Inverter can have _____ input (s). A. 1 B.2 C. 3 D.4 E. A lot of

9. For the gate below function F is correspondent to column ____.
A.1 B.2 C.3 D.4 E 5

X	Y	1	2	3	4	5
1	1	0	0	1	1	1
1	0	1	0	1	0	0
0	1	1	0	1	0	0
0	0	1	1	0	0	1



10. Duality principle states that every algebraic expression
A. remains valid if the operators and identity elements are changed.
B. remains valid if the operators and identity elements are interchanged.
C. deducible from the postulates of Boolean algebra remains valid if the operators and identity elements are changed.
D. deducible from the postulates of Boolean algebra remains valid if the operators and identity elements are interchanged.
E. deducible from the postulates of Boolean algebra remains valid if the operators are changed.

Test answers

1. **E.5**
2. **XOR GATE IS E**
3. **E. less than 10**
4. **D.NAND**
5. **D.NAND**
6. **C.NOR**
7. **C.Transfer**
8. **A.1**
9. **E.5**
10. **D**