

**ISTANBUL TECHNICAL UNIVERSITY
COMPUTER ENGINEERING DEPARTMENT**

**BLG 242E
DIGITAL CIRCUITS LABORATORY
EXPERIMENT REPORT**

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1 INTRODUCTION

This report aims to provide a comprehensive understanding of the various components of the CADET system and how to utilize them effectively. In particular, it will focus on recalling the axioms and theorems of Boolean algebra and observing them in practice through experimentation. By the end of this report, readers will have a solid understanding of the fundamental principles of digital logic and the tools required to design and implement digital circuits.

2 MATERIALS AND METHODS

2.1 PRELIMINARY

2.1.1 To Prove Absorption

$$\begin{aligned} a + ab &\iff a1 + ab \text{(Identity)} \\ a1 + ab &\iff a(b + 1) \text{(Distributive)} \\ a(b + 1) &\iff a1 \text{(Dominance)} \\ a1 &\iff a \text{(Identity)} \end{aligned}$$

2.1.2 To Prove Duality

prove the duals of the equalities

$$\begin{aligned} a + ab &\iff a(a + b) \\ a1 + ab &\iff aa + ab \text{ (Identity, Distributive)} \\ a + ab &\iff a + ab \text{ (Identity, Idempotency)} \end{aligned}$$

2.1.3 De Morgan Rule

prove the duals of the equalities

$$\begin{aligned} F1 &\iff ab + a'c \\ F2 &\iff (F1)' \iff (a' + b')(a + c') \end{aligned}$$

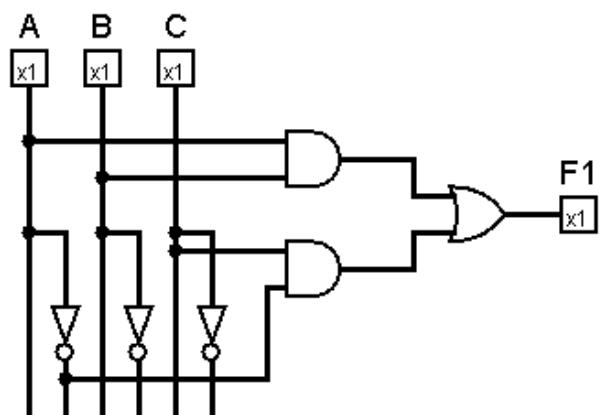


Figure 1: $F1(a, b) \iff ab + a'c[1]$

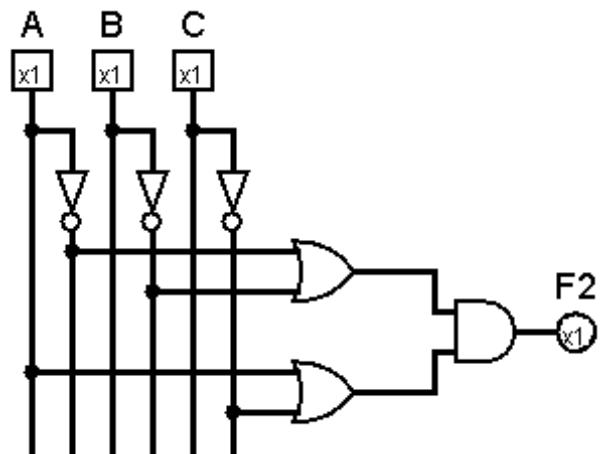


Figure 2: $F2(a, b) \iff (a + b) \cdot (a + b')[1]$

2.1.4 Simplifying Expression

Minterms	Binary Rep.	State
m(1)	0 0 0 1	✓
m(2)	0 0 1 0	✓
m(5)	0 1 0 1	✓
m(6)	0 1 1 0	✓
m(9)	1 0 0 1	✓
m(10)	1 0 1 0	✓
m(13)	1 1 0 1	✓
m(14)	1 1 1 0	✓

Table 1: First Table For Quine-McCluskey Method

Minterms	Binary Rep.	State
m(1), m(5)	0 - 0 1	✓
m(1), m(9)	- 0 0 1	✓
m(2), m(6)	0 - 1 0	✓
m(2), m(10)	- 0 1 0	✓
m(5), m(13)	- 1 0 1	✓
m(6), m(14)	- 1 1 0	✓
m(9), m(13)	1 - 0 1	✓
m(10), m(14)	1 - 1 0	✓

Table 2: Second Table For Quine-McCluskey Method

Minterms	Binary Rep.	State
m(1), m(5), m(9), m(13)	- - 0 1	✓
m(2), m(6), m(10), m(14)	- 0 - 0	✓

Table 3: Third Table For Quine-McCluskey Method

The final expression for the function $F(a, b, c, d) \iff u1(1, 2, 5, 6, 9, 10, 13, 14)$ is related to the Quine-McCluskey method is $c'd + cd'$.

2.2 MATERIALS

The equipment and ICs listed for use in the experiment are essential tools in the field of electronics. The C.A.D.E.T. (Complete Analogue Digital Electronic Trainer) is a comprehensive training system designed to teach and practice electronic circuits and systems. It provides a platform for students to build, test, and troubleshoot various electronic circuits. The 74000 series ICs are a popular and widely used family of integrated circuits, including the 74xx104 Hex Inverter, which is used to invert digital signals. The 74xx08 Quadruple 2-input Positive AND Gates and 74xx32 Quadruple 2-input Positive OR Gates are logic gates that perform the AND and OR operations, respectively. These ICs are commonly used in digital electronics to implement Boolean algebraic functions. In summary, these tools and ICs play a critical role in the design and development of electronic systems.

3 RESULTS [15 points]

3.1 EXPERIMENT-1

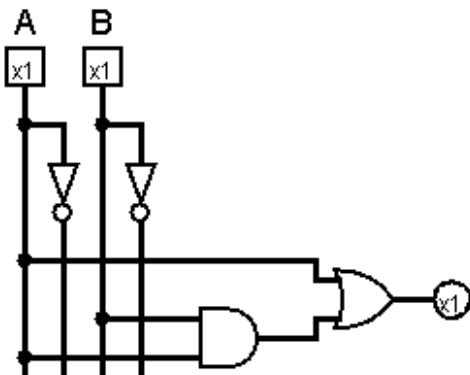


Figure 3: Diagram For $F1(a, b) = a + a \cdot b$

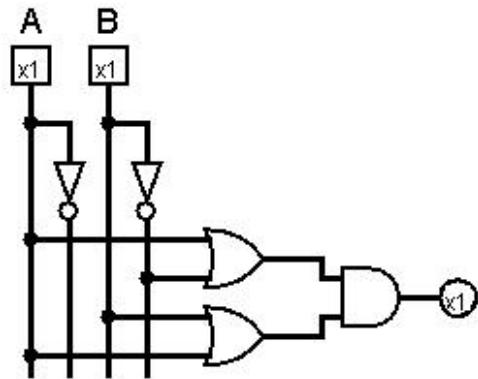


Figure 4: Diagram For $F2(a, b) = (a + b) \cdot (a + b')$

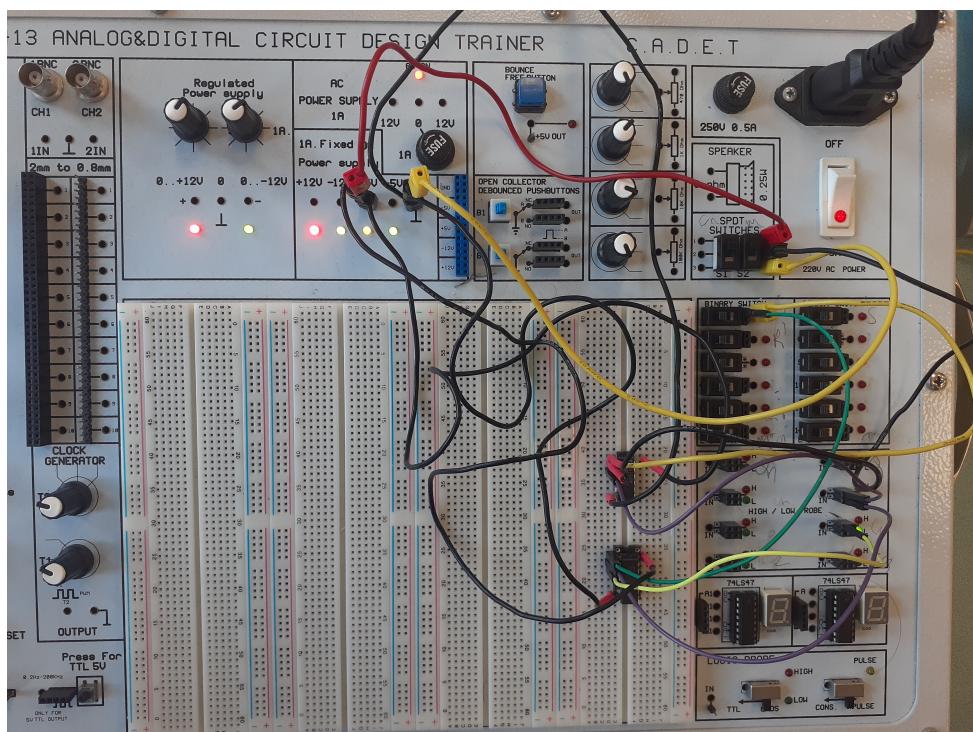


Figure 5: CADET image for Exp-1

First, we placed the AND and OR gates and connected the Vcc and ground voltages to the gates. We created a and b variables according to the given function and displayed the output with led.

3.2 EXPERIMENT-2

The duality theorem is stated in the Preliminary 2.1.2 section above. The duality of this expression is $a(a + b)$.

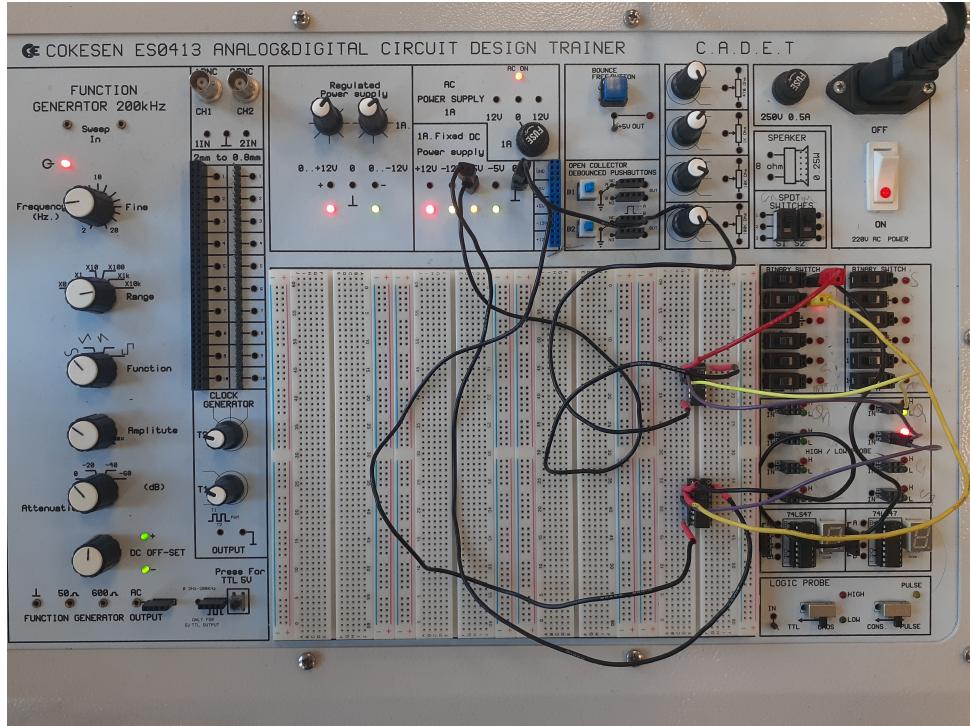


Figure 6: CADET image for Exp-2

We checked the truth table of the function thanks to the led system and verified the values in the truth table.

3.3 EXPERIMENT-3

Complement of $F_3(a,b,c)$ "ab + a'c" is:

$$(ab + a'c)' \iff (a' + b')(a + c')$$

a	b	c	a'	b'	c'	a'+ b'	a + c'	(a'+ b')(a + c')
0	0	0	1	1	1	1	1	1
0	0	1	1	1	0	1	0	0
0	1	0	1	0	1	1	1	1
0	1	1	1	0	0	1	0	0
1	0	0	0	1	1	1	1	1
1	0	1	0	1	0	1	1	1
1	1	0	0	0	1	0	1	0
1	1	1	0	0	0	0	1	0

Table 4: Truth Table For Complementary Function(F'3)

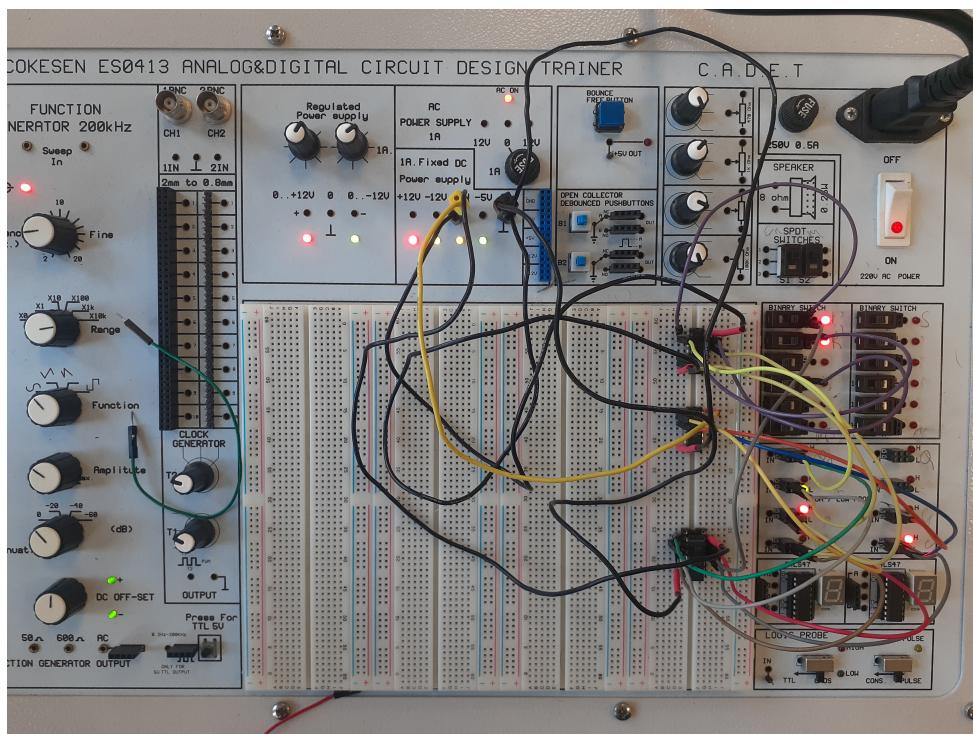


Figure 7: CADET image for Exp-3

3.4 EXPERIMENT-4

In Preliminary 2.1.4, the simplification for the experiment was made. The resulting expression is: $c'd + cd'$.

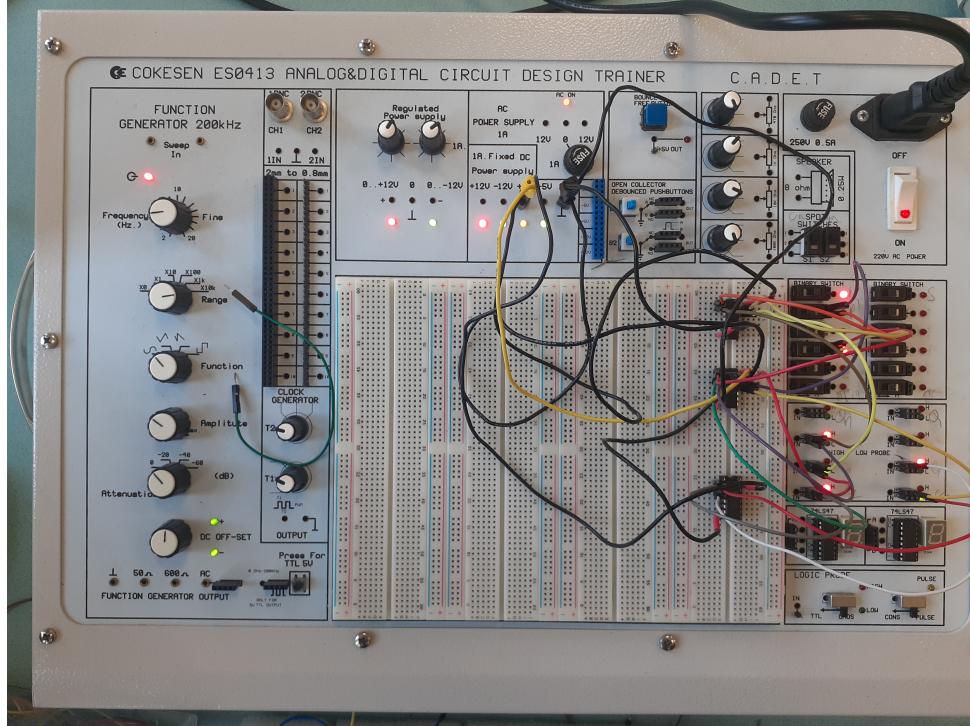


Figure 8: CADET image for Exp-4

4 DISCUSSION

In the first experiment, we grasped the use of CADET and AND, OR and NOT gates. We made it usable by connecting the gates to the required voltage values. We created input values and checked the output values created according to these values.

For the second experiment, we created a schema to find the dual of the given function and create this expression in CADET. In the meantime, we had a problem due to the lack of contact in the cables and by touching the cables, we found out which cables we could not get the output from. When we changed the cables, we were able to view the output without any problem.

In the third experiment, our priority was to obtain the complementary of the given function. Then we created three separate variables and obtained the complementary of the inputs we created with NOT gate and used these values as new inputs. Then we obtained the desired output with AND and OR gate.

In the fourth experiment, we achieved simplification with the Quine-McCluskey Method, while we realized that we made an error in the value of a, we created the output for $a(cd' + c'd)$. At that time, we were able to display the values of the expression $(cd' + c'd)$ in the LED system. In the last part, while obtaining the output in the led system, we removed the cable connecting the a input and we obtained the actual output.

5 CONCLUSION

In these experiments we learned to use the CADET interface and gates. We have obtained the output of the functions in the system we created on CADET. In the meantime, we had some contact problems with the cables.

REFERENCES

- [1] LogicLab. Logic lab. *An example journal*, 22(4):10–16, February 2020.