King Mongkut's Institute of Technology Ladkrabang Computer Engineering International Program 01276112 Digital System Fundamentals

## Lab 4 - Boolean Minimization Using Quine-McCluskey Method

## **Learning Outcomes**

- 1. Minimize Boolean expression using Quine-McCluskey method.
- 2. Construct more complicated digital circuit.

## 1. Experiment

1. The following Boolean expression detects odd prime numbers.

$$f(A,B,C,D,E) = \sum m(1,3,5,7,11,13,17,19,23,29,31)$$

1.1. Use Quine-McCluskey method to find prime implicants.

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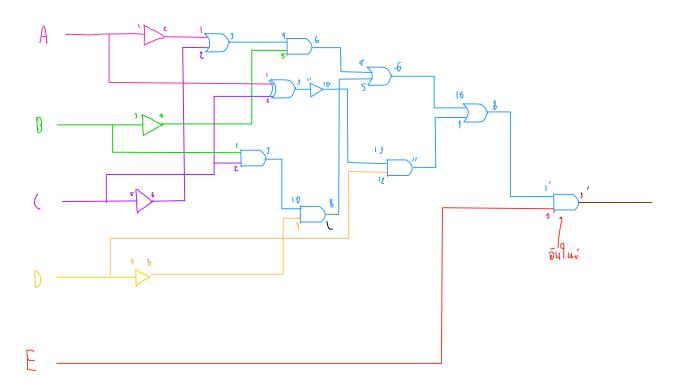
Minterms	A	В	С	D	E	group	Minterns	A	В	С	D	E		Minterns	Α	В	С	D	E	
1	0	0	0	0	1	1	1,3	0	0	0	_	1	/	1,3,5,7	0	0	_	-	1	
3	0	0	0	1	1	2	1,5	0	0	1	0	1	/	1,3,17,19		0	0		1	
5	0	0	1	0	1	2	1,17	_	0	0	0	1	/	3,7,19,23	-	0	_	1	1	
17	1	0	0	0	1	2	3,7	0	0	=	1	1	/							Т
7	0	0	1	1	1	3	3,11	0	_	0	1	1	PI4							
11	0	1	0	1	1	3	3,19	_	0	0	1	1	/							
13	0	1	1	0	1	3	5,7	0	0	1	_	1	/							
19	1	0	0	1	1	3	5,13	0	_	1	0	1	PI5							
23	1	0	1	1	1	4	17,19	1	0	0	_	1	/							
29	1	1	1	0	1	4	7,23	20	0	1	1	1	/							
31	1	1	1	1	1	5	13,29		1	1	0	1	PI6							
							19,23	1	0	828	1	1	/							
							23,31	1		1	1	1	PI7							
							29,31	1	1	1		1	PI8							

Minterm	List of prime Implicants
3,11	ÁĆDE
5,13	A'CD'E
13,29	BCD'E
23,31	ACDE
29,31	ABCE
1,3,5,7	A'B'E
1,3,17,19	B'C'E
3,7,19,23	B'DE

.....

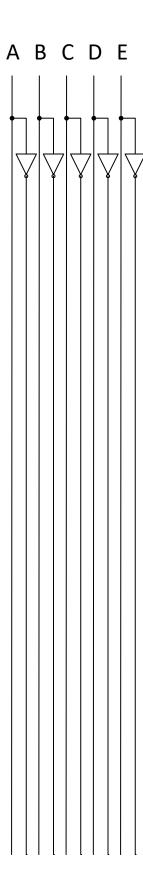
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1.4. Draw logic diagram and specify IC pin No. for all input and output pins of each gate.



$$= E \left[ D(A \oplus C)' + B'(A'+C') + BCD' \right]$$

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2. Construct the circuit from Experiment 1.4 and record the output.

1 0 0 0 0 1 2 0 0 1 2 0 0 0 1 0 0 1 0 0 0 0		Α	В	С	D	E	Output
2 0 0 0 1 0 1 0 3 0 0 0 1 1 1 1 4 0 0 0 1 0 0 0 0 0 0 0 0	Ð	0	0	0	0	0	
3 0 0 0 1 1 1 4 0 0 0 9 0 1 1 0 0 0 9 0 1 0 0 0 0 0 0 0	1	0	0	0	0	1	
4 0 0 1 0 0 0 9 0 0 0 0 0 0 0 0 0 0 0 0 0	2	0	0	0	1	0	
9 0 0 1 0 1 6 0 0 1 1 0 7 0 0 1 1 1 8 0 1 0 0 0 9 0 1 0 0 1 0×1 10 0 1 0 1 0 11 0 1 1 1 12 0 1 1 0 0 13 0 1 1 0 0 14 0 1 1 0 0	3	0	0	0	1	1	
6 0 0 1 1 0 0 7 0 0 0 9 0 1 0 0 1 0 1 0 1 1 1 1 1 1 1 1	4	0	0	1	0	0	
7 0 0 1 1 1 1 9 0 0 9 0 1 0 0 0 0 1 0 0 1 0 0 1 0 1	9	0	0	1	0	1	
3 0 1 0 0 0 9 0 1 0 0 1 0×1 10 0 1 0 1 0 11 0 1 1 1 12 0 1 1 0 0 13 0 1 1 0 1 14 0 1 1 1 0	6	0	0	1	1	0	
9 0 1 0 0 1 0×1 10 0 1 0 1 0 11 0 1 1 1 12 0 1 1 0 0 13 0 1 1 0 1 14 0 1 1 1 0	7	0	0	1	1	1	
10 0 1 0 1 0 11 0 1 0 1 1 12 0 1 1 0 0 13 0 1 1 0 1 14 0 1 1 1 0	8	0	1	0	0	0	
11     0     1     0     1     1       12     0     1     1     0     0       13     0     1     1     0     1       14     0     1     1     1     0	9	0	1	0	0	1	0×1
12 0 1 1 0 0 13 0 1 1 0 1 14 0 1 1 1 0	10	0	1	0	1	0	
13 0 1 1 0 1 14 0 1 1 1 0	11	0	1	0	1	1	
14 0 1 1 1 0	12	0	1	1	0	0	
	13	0	1	1	0	1	
10 0 1 0 0 1	14	0	1	1	1	0	
19 0 1 1 1 1 0 × 1	15	0	1	1	1	1	0 × 1

	Α	В	С	D	Е	Output
16	1	0	0	0	0	
17	1	0	0	0	1	
8	1	0	0	1	0	
19	1	0	0	1	1	
20	1	0	1	0	0	
21	1	0 (	1	0	1	0 ×1
92	1	0	1	1	0	
23	1	0	1	1	1	
24	1	1	0	0	0	
29	1	1	0	0	1	0×1
26	1	1	0	1	0	
27	1	1	0	1	1	0×1
28	1	1	1	0	0	
29	1	1	1	0	1	
30	1	1	1	1	0	
31	1	1	1	1	1	

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#### Lab 4 Submission

Date 7 January 2025 Group No. 13

- 1. Student ID 67011590 Name Watcharathorn krachan non
- 2. Student ID 67011594 Name Chythathip Termohaiky)
- 3. Student ID 67011385 Name Worawalun Sombutphotiudom

### Checkpoint

Experiment 1 (10 pts)

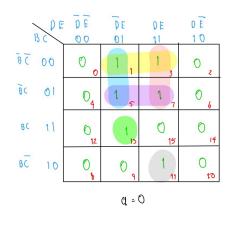
Experiment 2 (10 pts)

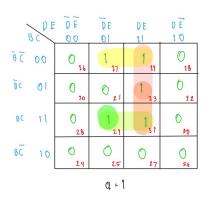
#### **Questions**

1. Can you minimize the following Boolean expression using K-Map method. If you can, do the demonstration. Or specify the reason if you cannot.

$$f(A,B,C,D,E) = \sum m(1,3,5,7,11,13,17,19,23,29,31)$$

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2. Compare Quine McClusky and K-Map methods for minimization five or more variables.

Quine - McCluskey Method is suited for large numbers of variables which can handles function with five or more variables. However, it requires a lot of manual calculations if not automated. For accuracy it minimizes errors in manual operations compared to K-Maps. For the K-Map methods is become impractical when there are five or more variable due to the map's size.

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fcA,B,C,D,E): BCE + BDE + BCDE + ABDE + ABCE+ ACDE+ ABCE + ABCOE

f(A,B,C,D)= BCD'E + ABCE + A'B'R+B'C'E
