# COMPUTER ORGANISATION
## (TỔ CHỨC MÁY TÍNH)

# Quine-McCluskey

# Acknowledgement


- The contents of these slides have origin from School of Computing, National University of Singapore.
- We greatly appreciate support from Mr. Aaron Tan Tuck Choy for kindly sharing these materials.

# Policies for students

- These contents are only used for students PERSONALLY.
- Students are NOT allowed to modify or deliver these contents to anywhere or anyone for any purpose.

# Quine-McCluskey

- A tabulation method similar in concept to K-map
- Applicable for functions with any number of variables
  - K-map is useful for functions with at most 5 or 6 variables
- Tedious on paper, but can be automated (programmed)
- Non-examinable
  - But knowing it may enhance your understanding of K-maps

# PIs AND EPIs

- To find the simplest (minimal) SOP expression from a K-map, you need to obtain:
  - Minimum number of literals per product term; and
  - Minimum number of product terms.
- Achieved through K-map using
  - *Bigger groupings* of minterms (prime implicants) where possible; and
  - *No redundant groupings* (look for essential prime implicants)

# EXAMPLE: F(A,B,C,D) = $\Sigma m(2,3,4,5,7,8,10,13,15)$

**Step 1:** List out all minterms in groups with same number of 1s in their binary codes.

**1st column**

2: 0010
4: 0100
8: 1000

Codes with one 1

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3: 0011
5: 0101
10: 1010

Codes with two 1s

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7: 0111
13: 1101

Codes with three 1s

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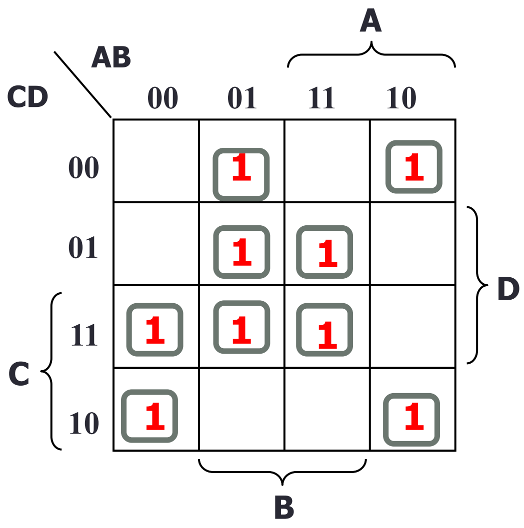
15: 1111

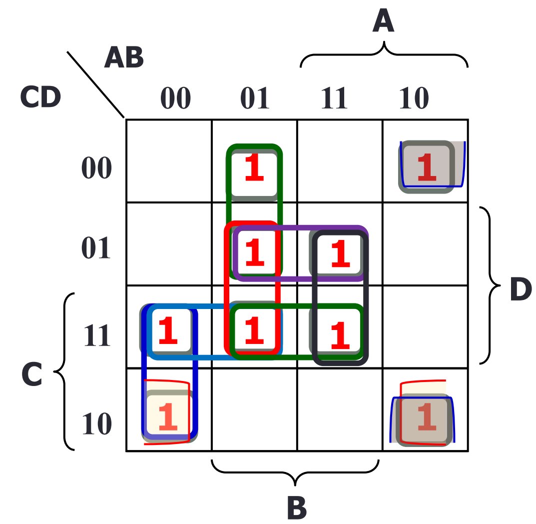
Codes with four 1s



# EXAMPLE: F(A,B,C,D) = $\Sigma m(2,3,4,5,7,8,10,13,15)$

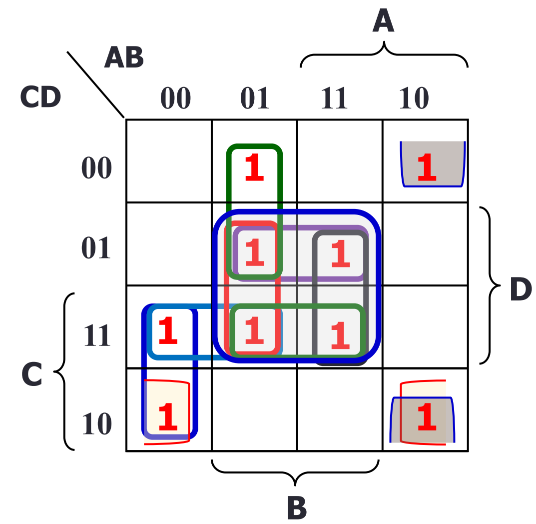
**Step 2:** Combine codes that differ by 1 bit into bigger group, write the combined code in next column.

| **1st column** | **2nd column** | |
|---|---|---|
| ✓✓ 2: 0010 | 2,3: 001- | Codes with one 1 |
| ✓ 4: 0100 | 2,10: -010 | |
| ✓ 8: 1000 | 4,5: 010- | |
| | 8,10: 10-0 | |
| ------------ | ------------------ | |
| ✓✓ 3: 0011 | 3,7: 0-11 | Codes with two 1s |
| ✓✓✓ 5: 0101 | 5,7: 01-1 | |
| ✓✓ 10: 1010 | 5,13: -101 | |
| ------------ | ------------------ | |
| ✓✓✓ 7: 0111 | 7,15: -111 | Codes with three 1s |
| ✓✓ 13: 1101 | 13,15: 11-1 | |
| ------------ | | |
| ✓✓ 15: 1111 | | |



# EXAMPLE: $F(A,B,C,D) = \Sigma m(2,3,4,5,7,8,10,13,15)$

**Step 3:** Repeat step 2 – Combine codes that differ by 1 bit into bigger group, write the combined code in next column.




**1st column**

✓ 2: 0010
✓ 4: 0100
✓ 8: 1000
------------
✓ 3: 0011
✓ 5: 0101
✓10: 1010
------------
✓ 7: 0111
✓13: 1101
------------
✓15: 1111

**2nd column**

2,3: 001-
2,10: -010
4,5: 010-
8,10: 10-0
---------------
3,7: 0-11
✓ 5,7: 01-1
✓ 5,13: -101
---------------
✓ 7,15: -111
✓13,15: 11-1

**3rd column**

5,7,13,15: -1-1
~~5,7,13,15: -1-1~~

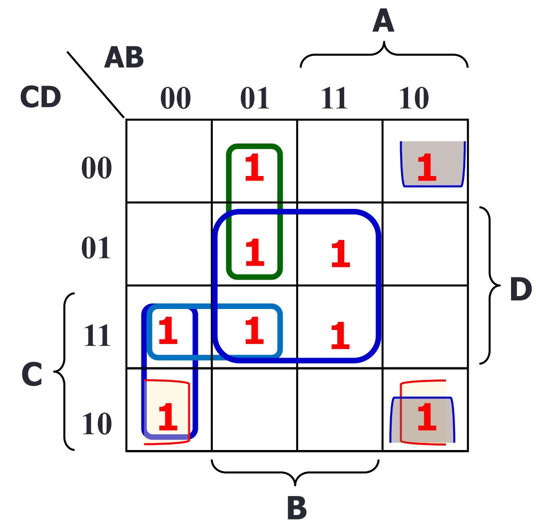
We have completed **Phase 1**: Identifying all the Prime Implicants (PIs)!

# EXAMPLE: $F(A,B,C,D) = \Sigma m(2,3,4,5,7,8,10,13,15)$

## Phase 2: Identify the Essential Prime Implicants (EPIs)

- Draw the PI chart

| | | 2 | 3 | 4 | 5 | 7 | 8 | 10 | 13 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2,3: 001- (A'.B'.C) | ✓ | ✓ | | | | | | | |
| | 2,10: -101 (B.C'.D) | ✓ | | | | | | ✓ | | |
| EPI | 4,5: 010- (A'.B.C') | | | ✓ | ✓ | | | | | |
| EPI | 8,10: 10-0 (A.B'.D') | | | | | | ✓ | ✓ | | |
| | 3,7: 0-11 (A'.C.D) | | ✓ | | | ✓ | | | | |
| EPI | 5,7,13,15: -1-1 (B.D) | | | | ✓ | ✓ | | | ✓ | ✓ |




Where are the EPIs? Look for columns containing a single tick.

EPIs are: A'.B.C', A.B'.D', and B.D

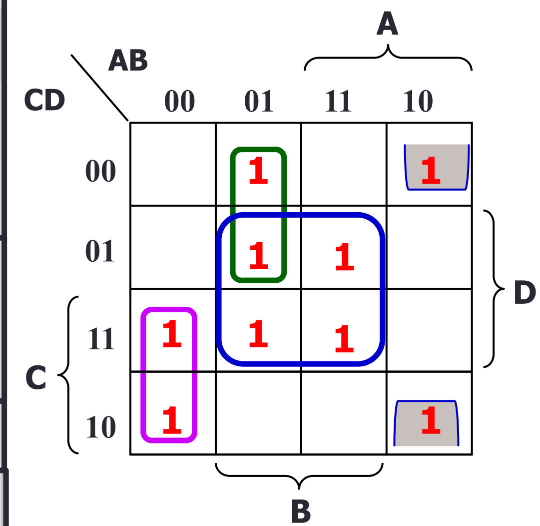
But we are not done yet. There are still minterms not covered by the EPIs!

# EXAMPLE: F(A,B,C,D) = $\Sigma m(2,3,4,5,7,8,10,13,15)$

## Phase 2: After identifying the EPIs

- Draw the reduced PI chart if there are minterms not covered

| | 2 | 3 | 4 | 5 | 7 | 8 | 10 | 13 | 15 |
|---|---|---|---|---|---|---|---|---|---|
| 2,3: 001- (A'.B'.C) | ✓ | ✓ | | | | | | | |
| 2,10: -101 (B.C'.D) | ✓ | | | | | | ✓ | | |
| EPI 4,5: 010- (A'.B.C') | | | ✓ | ✓ | | | | | |
| EPI 8,10: 10-0 (A.B'.D') | | | | | | ✓ | ✓ | | |
| 3,7: 0-11 (A'.C.D) | | ✓ | | | ✓ | | | | |
| EPI 5,7,13,15: -1-1 (B.D) | | | | ✓ | ✓ | | | ✓ | ✓ |




1. Find out what are the minterms covered by the EPIs.
2. Remove the EPIs and minterms they cover from the chart → reduced PI chart.
3. Find the minimum number of remaining PIs to cover the remaining minterms.

Answer:
B.D + A'.B.C' + A.B'.D' + A'.B'.C

# Q&A