

A decorative graphic on the left side of the slide, consisting of a network of thin, light-orange lines and small circles, resembling a circuit board or a stylized tree structure.

QUIZ

ECE 2372

ABBHEY GONZALES

# 2-BIT BINARY ADDER 1. DEC 4X16

Abbey Gonzales

Quiz

2-bit binary Adder

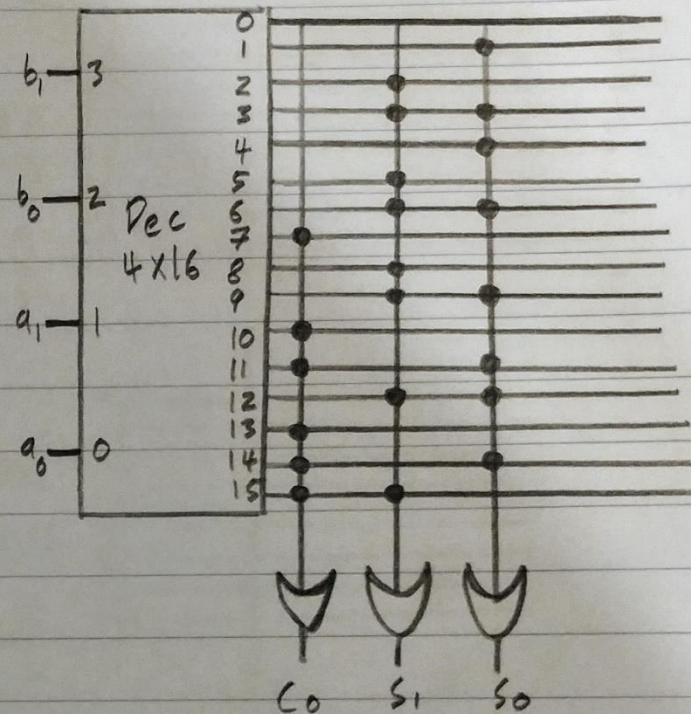
1. Dec 4x16

FIVE STAR.  
★★★★★

FIVE STAR.  
★★★★★

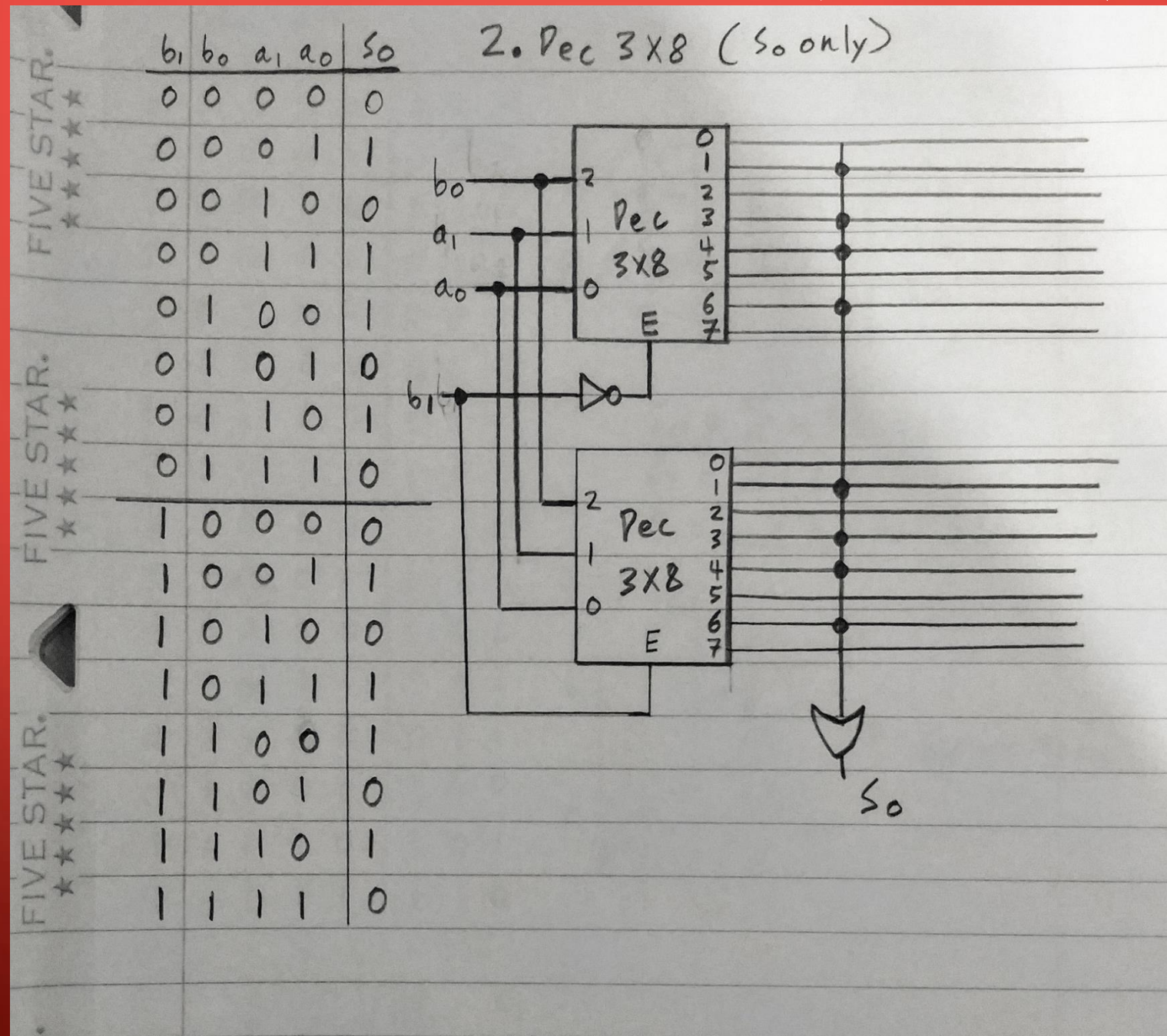
FIVE STAR.  
★★★★★

|    |  | B              |                | A              |                | Co S1 So |    |    |
|----|--|----------------|----------------|----------------|----------------|----------|----|----|
|    |  | b <sub>1</sub> | b <sub>0</sub> | a <sub>1</sub> | a <sub>0</sub> | Co       | S1 | So |
| 0  |  | 0              | 0              | 0              | 0              | 0        | 0  | 0  |
| 1  |  | 0              | 0              | 0              | 1              | 0        | 0  | 1  |
| 2  |  | 0              | 0              | 1              | 0              | 0        | 1  | 0  |
| 3  |  | 0              | 0              | 1              | 1              | 0        | 1  | 1  |
| 4  |  | 0              | 1              | 0              | 0              | 0        | 0  | 1  |
| 5  |  | 0              | 1              | 0              | 1              | 0        | 1  | 0  |
| 6  |  | 0              | 1              | 1              | 0              | 0        | 1  | 1  |
| 7  |  | 0              | 1              | 1              | 1              | 1        | 0  | 0  |
| 8  |  | 1              | 0              | 0              | 0              | 0        | 1  | 0  |
| 9  |  | 1              | 0              | 0              | 1              | 0        | 1  | 1  |
| 10 |  | 1              | 0              | 1              | 0              | 1        | 0  | 0  |
| 11 |  | 1              | 0              | 1              | 1              | 1        | 0  | 1  |
| 12 |  | 1              | 1              | 0              | 0              | 0        | 1  | 1  |
| 13 |  | 1              | 1              | 0              | 1              | 1        | 0  | 0  |
| 14 |  | 1              | 1              | 1              | 0              | 1        | 0  | 1  |
| 15 |  | 1              | 1              | 1              | 1              | 1        | 1  | 0  |





# 2-BIT BINARY ADDER 2. DEC 3X8 (S0 ONLY)



# 2-BIT BINARY ADDER 3. ROM & 4. PLA (PART 1)

**3. ROM**  $2^n \times m$   
 $n=4$   $m=3$

|    | B     |       | A     |       | $C_0$ | $S_1$ | $S_0$ |
|----|-------|-------|-------|-------|-------|-------|-------|
|    | $b_1$ | $b_0$ | $a_1$ | $a_0$ |       |       |       |
| 0  | 0     | 0     | 0     | 0     | 0     | 0     | 0     |
| 1  | 0     | 0     | 0     | 1     | 0     | 0     | 1     |
| 2  | 0     | 0     | 1     | 0     | 0     | 1     | 0     |
| 3  | 0     | 0     | 1     | 1     | 0     | 1     | 1     |
| 4  | 0     | 1     | 0     | 0     | 0     | 0     | 1     |
| 5  | 0     | 1     | 0     | 1     | 0     | 1     | 0     |
| 6  | 0     | 1     | 1     | 0     | 0     | 1     | 1     |
| 7  | 0     | 1     | 1     | 1     | 1     | 0     | 0     |
| 8  | 1     | 0     | 0     | 0     | 0     | 1     | 0     |
| 9  | 1     | 0     | 0     | 1     | 0     | 1     | 1     |
| 10 | 1     | 0     | 1     | 0     | 1     | 0     | 0     |
| 11 | 1     | 0     | 1     | 1     | 1     | 0     | 1     |
| 12 | 1     | 1     | 0     | 0     | 0     | 1     | 1     |
| 13 | 1     | 1     | 0     | 1     | 1     | 0     | 0     |
| 14 | 1     | 1     | 1     | 0     | 1     | 0     | 1     |
| 15 | 1     | 1     | 1     | 1     | 1     | 1     | 0     |

**4. PLA**

$S_0 = \sum m(1, 3, 4, 6, 9, 11, 12, 14)$   
 $S_1 = \sum m(2, 3, 5, 6, 8, 9, 12, 15)$   
 $C_0 = \sum m(7, 10, 11, 13, 14, 15)$

$F_1 = \bar{a}_0 b_0 + a_0 \bar{b}_0$

$F_2 = \bar{a}_1 b_1 \bar{b}_0 + \bar{a}_1 \bar{a}_0 b_1 + a_1 \bar{b}_1 \bar{b}_0 + a_1 \bar{a}_0 \bar{b}_1 + a_1 a_0 b_1 b_0$



# 2-BIT BINARY ADDER 4. APL (PART 2)

4. PLA (continued)

| B              |                | A              |                | C <sub>0</sub> S <sub>1</sub> S <sub>0</sub> |
|----------------|----------------|----------------|----------------|--|
| b <sub>1</sub> | b <sub>0</sub> | a <sub>1</sub> | a <sub>0</sub> |  |
| 0              | 0              | 0              | 0              | 000  |
| 0              | 0              | 0              | 1              | 001  |
| 0              | 0              | 1              | 0              | 010  |
| 0              | 0              | 1              | 1              | 011  |
| 0              | 1              | 0              | 0              | 100  |
| 0              | 1              | 0              | 1              | 101  |
| 0              | 1              | 1              | 0              | 110  |
| 0              | 1              | 1              | 1              | 111  |
| 1              | 0              | 0              | 0              | 010  |
| 1              | 0              | 0              | 1              | 011  |
| 1              | 0              | 1              | 0              | 100  |
| 1              | 0              | 1              | 1              | 101  |
| 1              | 1              | 0              | 0              | 011  |
| 1              | 1              | 0              | 1              | 100  |
| 1              | 1              | 1              | 0              | 101  |
| 1              | 1              | 1              | 1              | 110  |

$$F_1(S_0) = \bar{a}_0 b_0 + a_0 \bar{b}_0$$

$$F_2(S_1) = \bar{a}_1 b_1 \bar{b}_0 + \bar{a}_1 \bar{a}_0 b_1 + a_1 \bar{b}_1 \bar{b}_0 + a_1 \bar{a}_0 \bar{b}_1 + a_1 a_0 b_1 b_0$$

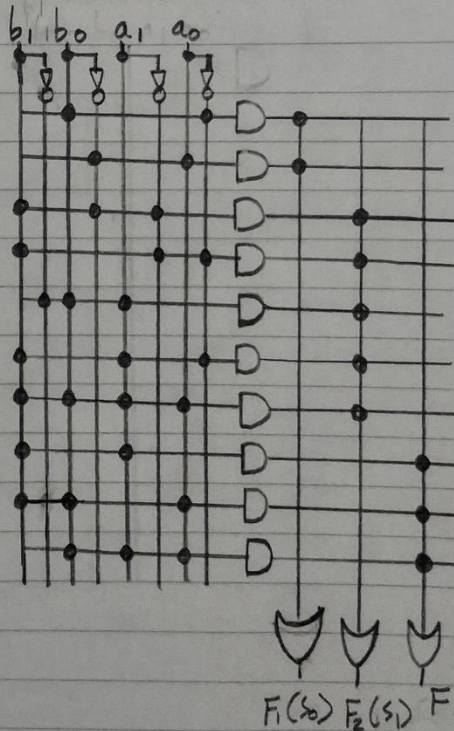
|                |   | b <sub>1</sub> |   | b <sub>0</sub> |   |
|----------------|---|----------------|---|----------------|---|
|                |   | 0              | 1 | 0              | 1 |
| a <sub>1</sub> | 0 | 0              | 0 | 0              | 0 |
|                | 1 | 0              | 0 | 0              | 0 |
| a <sub>0</sub> | 0 | 0              | 0 | 0              | 0 |
|                | 1 | 0              | 0 | 0              | 0 |

$$F_3 = a_1 b_1 + a_0 b_0 b_1 + a_1 a_0 b_0$$

$$F_1(S_0) = \bar{a}_0 b_0 + a_0 \bar{b}_0$$

$$F_2(S_1) = \bar{a}_1 b_1 \bar{b}_0 + \bar{a}_1 \bar{a}_0 b_1 + a_1 \bar{b}_1 \bar{b}_0 + a_1 \bar{a}_0 b_1 + a_1 a_0 b_1 b_0$$

$$F_3(C_0) = a_1 b_1 + a_0 b_0 b_1 + a_1 a_0 b_0$$



# 2-BIT BINARY ADDED 5 TRI-STATE (S1 ONLY)

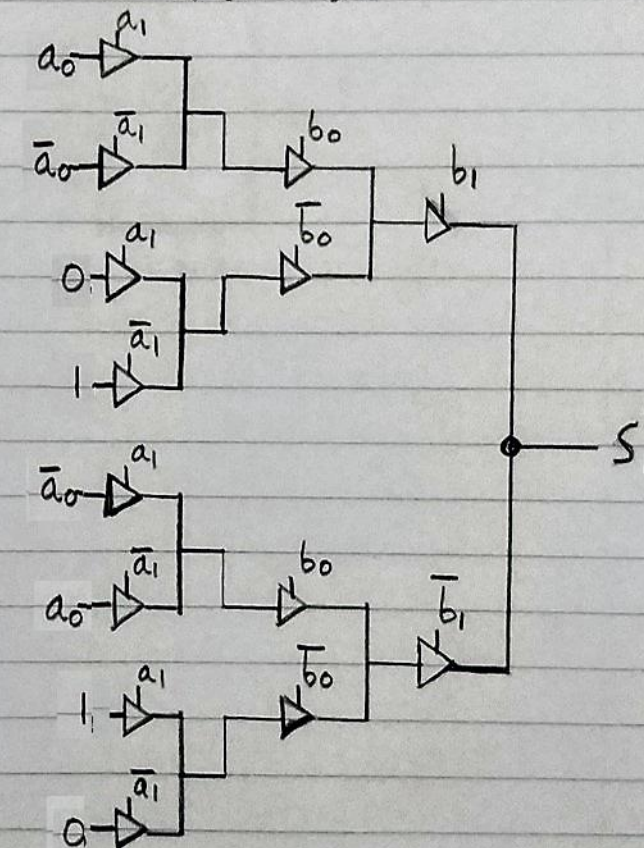
5. Tri-State ( $S_1$  only)

$B$   $A$   
 $b_1$   $b_0$   $a_1$   $a_0$   $S_1$

|   |   |   |   |   |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 1 | 0 | 1 |
| 0 | 0 | 1 | 1 | 1 |
| 0 | 1 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 | 1 |
| 0 | 1 | 1 | 0 | 1 |
| 0 | 1 | 1 | 1 | 0 |
| 1 | 0 | 0 | 0 | 1 |
| 1 | 0 | 0 | 1 | 1 |
| 1 | 0 | 1 | 0 | 0 |
| 1 | 0 | 1 | 1 | 0 |
| 1 | 1 | 0 | 0 | 1 |
| 1 | 1 | 0 | 1 | 0 |
| 1 | 1 | 1 | 0 | 0 |
| 1 | 1 | 1 | 1 | 1 |

$$S_1 = \sum m(2, 3, 5, 6, 8, 9, 12, 15)$$

|   |       |       |       |       |             |       |       |             |
|---|-------|-------|-------|-------|-------------|-------|-------|-------------|
| 8 | $b_1$ | 0     | 1     | 0     | 1           | 0     | 0     | 1           |
| 4 | $b_0$ | 0     | 0     | 1     | 0           | 0     | 0     | 1           |
| 2 | $a_1$ | 0     | 0     | 0     | 0           | 1     | 1     | 1           |
|   | $a_0$ | 1     | 0     | 1     | 1           | 0     | 0     | 0           |
|   |       | $I_0$ | $I_1$ | $I_2$ | $I_3$       | $I_4$ | $I_5$ | $I_6$       |
|   |       | 0     | 0     | 4     | 2           | 2     | 10    | 6           |
|   |       | 1     | 9     | 5     | 3           | 3     | 11    | 7           |
|   |       | 0     | 1     | $a_0$ | $\bar{a}_0$ | 1     | 0     | $\bar{a}_0$ |





# 2-BIT BINARY ADDER 6. MUX 8X1 (C0 ONLY)

6. MUX 8X1 (C0 only)

$C_0 = \sum m(7, 10, 11, 13, 14, 15)$

|   | B     |       | A     |       | $C_0$ |
|---|-------|-------|-------|-------|-------|
|   | $b_1$ | $b_0$ | $a_1$ | $a_0$ | $C_0$ |
| 0 | 0     | 0     | 0     | 0     | 0     |
| 0 | 0     | 0     | 0     | 1     | 0     |
| 0 | 0     | 0     | 1     | 0     | 0     |
| 0 | 0     | 0     | 1     | 1     | 0     |
| 0 | 0     | 1     | 0     | 0     | 0     |
| 0 | 0     | 1     | 0     | 1     | 0     |
| 0 | 0     | 1     | 1     | 0     | 0     |
| 0 | 0     | 1     | 1     | 1     | 1     |
| 1 | 0     | 0     | 0     | 0     | 0     |
| 1 | 0     | 0     | 0     | 1     | 0     |
| 1 | 0     | 0     | 1     | 0     | 1     |
| 1 | 0     | 0     | 1     | 1     | 1     |
| 1 | 0     | 1     | 0     | 0     | 0     |
| 1 | 0     | 1     | 0     | 1     | 1     |
| 1 | 0     | 1     | 1     | 0     | 1     |
| 1 | 0     | 1     | 1     | 1     | 1     |

Truth Table for  $C_0$  (MUX 8X1):

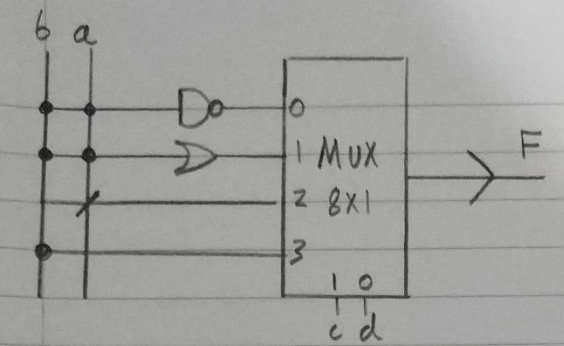
| $I_0$ | $I_1$ | $I_2$ | $I_3$ | $I_4$ | $I_5$ | $I_6$ | $I_7$ |
|-------|-------|-------|-------|-------|-------|-------|-------|
| 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     |
| 0     | 0     | 0     | 0     | 0     | 0     | 0     | 1     |
| 0     | 0     | 0     | 0     | 0     | 1     | 0     | 0     |
| 0     | 0     | 0     | 0     | 0     | 1     | 1     | 0     |
| 0     | 0     | 0     | 0     | 1     | 0     | 0     | 0     |
| 0     | 0     | 0     | 0     | 1     | 0     | 1     | 0     |
| 0     | 0     | 0     | 0     | 1     | 1     | 0     | 0     |
| 0     | 0     | 0     | 0     | 1     | 1     | 1     | 1     |

MUX 8X1 Diagram:

The MUX 8X1 has 8 inputs labeled  $I_0$  through  $I_7$ . The outputs are labeled  $b_0$ ,  $a_1$ , and  $a_0$ . The output  $F$  is connected to the output of the MUX.

# 1. $\sum$ MINTERMS ( ) 2. $F(A,B,C,D)$ 3. $\prod$ MAXTERMS ( )

**FIVE STAR** ★★★★★



| a | b | c | d | F |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 1 | 0 |
| 0 | 1 | 0 | 0 | 1 |
| 0 | 1 | 0 | 1 | 1 |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 | 1 |
| 1 | 0 | 0 | 0 | 1 |
| 1 | 0 | 0 | 1 | 0 |
| 1 | 0 | 1 | 0 | 0 |
| 1 | 0 | 1 | 1 | 0 |
| 1 | 1 | 0 | 0 | 1 |
| 1 | 1 | 0 | 1 | 1 |
| 1 | 1 | 1 | 0 | 0 |
| 1 | 1 | 1 | 1 | 1 |

**FIVE STAR** ★★★★★

1.  $\sum m( )$ ?

$$F = \bar{c}\bar{d}(a\bar{b}) + \bar{c}d(a+b) + cd(\bar{a}) + cd(b)$$

$$= \bar{c}\bar{d}(\bar{a}+\bar{b}) + a\bar{c}d + ab\bar{c} + \bar{a}cd + bcd$$

$$= \bar{a}\bar{c}\bar{d} + \bar{b}\bar{c}\bar{d} + a\bar{c}d + ab\bar{c} + \bar{a}cd + bcd$$

$$= \bar{a}(1)\bar{c}\bar{d} + (1)\bar{b}\bar{c}\bar{d} + \bar{a}(1)\bar{c}d + ab\bar{c}(1) + \bar{a}(1)cd + (1)bcd$$

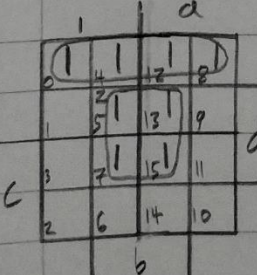
$$= \bar{a}(b+\bar{b})\bar{c}\bar{d} + (a+\bar{a})\bar{b}\bar{c}\bar{d} + \bar{a}(b+\bar{b})\bar{c}d + ab\bar{c}(d+\bar{d}) + \bar{a}(b+\bar{b})cd + (a+\bar{a})bcd$$

$$= \bar{a}b\bar{c}\bar{d} + \bar{a}\bar{b}\bar{c}\bar{d} + \bar{a}b\bar{c}d + \bar{a}\bar{b}\bar{c}d + ab\bar{c}d + ab\bar{c}\bar{d} + \bar{a}bcd + \bar{a}b\bar{c}d + abcd + \bar{a}bcd$$

$$F = \sum m(0, 4, 5, 7, 8, 12, 13, 15)$$

**FIVE STAR** ★★★★★

2.  $F = f(a, b, c, d) = ?$



$$f(a, b, c, d) = \bar{c}\bar{d} + bd$$

**FIVE STAR** ★★★★★

3.  $\prod M( )$ ?

$$\prod M(1, 2, 3, 6, 9, 10, 11, 14)$$