CSE260 Practice Sheet

Q: Are all of these enough to get full marks in the exam?

A: NO. This is a practice sheet. Meaning, you can practice all you want using the questions from this sheet. However, doing well in exams depends upon your ability to understand a question, formulate an answer, and express it correctly. You see, these are humane skills which cannot be guaranteed from completing a practice sheet only. But yeah, Best of luck anyways.

- Convert the following binary numbers to equivalent decimal numbers.
  (a) $(101110001001)_2$
  (b) $(11011.101)_2$
- Convert the following decimal number to equivalent binary numbers: $(4195)_{10}$
- Convert the following decimal number to equivalent binary numbers: $(3785.65625)_{10}$
- Convert the following decimal number to equivalent binary numbers: $(4785.150263)_{10}$ [for infinite fractional part, just do 6-7 steps and use dots for the rest]
- Convert the following decimal number to equivalent base 5 numbers: $(4123)_{10}$
- Convert the following decimal number to equivalent hexadecimal numbers: $(513)_{10}$
- Convert the following decimal number to equivalent base 9 numbers: $(813)_{10}$
- Perform the following base conversions
  a) $(29)_{12} = (?)_7$
  b) $(10110111)_5 = (?)_4$
- Perform addition, subtraction and multiplication for the pair of following base-9 numbers. Verify your results by converting the problem into decimal.
  412
  134
- Subtract 13 from 27 in 7 bits using 2's complement number system and justify whether there is an overflow or not.
- Subtract 45 from 98 in 12 bits using 2's complement number system and justify whether there is an overflow or not.
- Add 13 with 27 in 6 bits using 2's complement number system and justify whether there is an overflow or not.
- Add -57 with 63 in 11 bits using 2's complement number system and justify

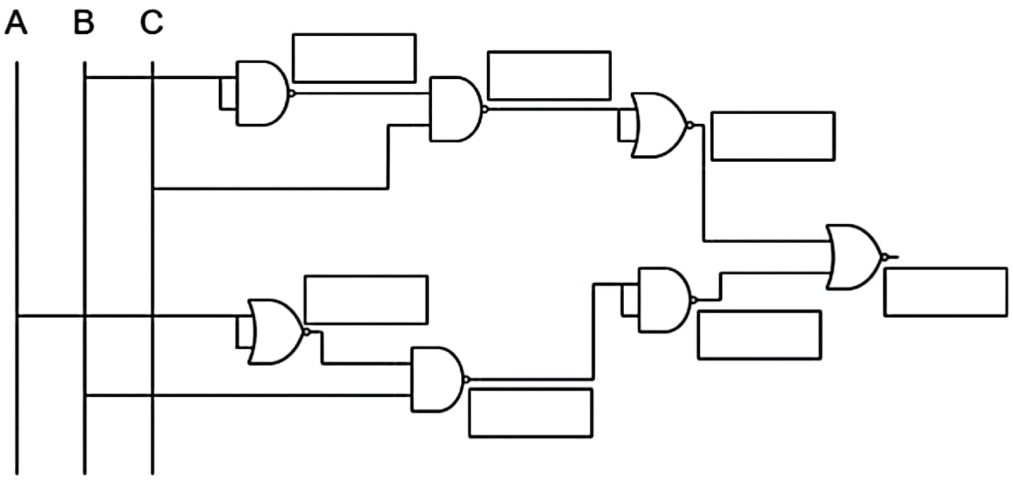
whether there is an overflow or not.

- Perform the following arithmetic operations using 13-bit two's complement and one's complement systems . State if there is an overflow in each case.

  a) 91 - 499
  b) 379 + 98

- You are a computer engineer and you want to buy two 8 GB DDR4 RAMs. Each RAM costs $(1C2)_{16}$ dollars. You also want to buy a graphics card RTX4070Ti which costs $(10010110000)_2$ dollars. However, you don't have that much money with you and you are afraid to ask your parents about it. Suddenly, one of your generous friends agreed to give you the money you need. He decided to give you $(4064)_8$ dollars. How much will you have left after buying those components? (Show the answer in decimal)
- Simplify the following boolean expression to minimum number of literals:
  $(A + B)(A + \bar{B})(\bar{A} + C)$
- Find the complement of the following expression:
  $(x' + y + z')(x' + y')(x + z')$

- Determine the logic function of the above circuit. Use the boxes in the diagram to write your answer step by step.



- Draw the following functions using NAND gates only:
  F(A,B,C,D) = (A'B'CD' + A'D + (B+D'))
  NB: Please draw horizontally on your script.
  NB: You can't simplify the above functions and then draw using NAND gate. You have to draw based on the function given in question
- Draw the following functions using NOR gates only:
  F(A,B,C,D) = (AB'C'D' + AD + (B+D'))
  NB: Please draw horizontally on your script.
  NB: You can't simplify the above functions and then draw using NAND gate. You have to draw based on the function given in question

- Find out SOP and POS for the following:
    1. F(A,B,C) = AB+BC'
    2. F(A,B,C,D) = A+ B'CD'
    3. F(A,B,C,D,E) = AB+CDE
- **Simplify** the following boolean equation using the laws of boolean algebra and implement the simplified function using only NOR gates:
  F(a,b,c,d) = Σ(8, 9, 10, 11, 13, 15)
- Find the simplified function using K-map:
    1. F(a,b,c,d) = Σ(8, 9, 10, 11, 13, 15)
    2. F(a,b,c,d) = Σ(0, 1, 2, 11, 13, 15)
    3. F(a,b,c) = Σ(0,3,5,7)
    4. F(a,b,c,d) = Σ(8, 9, 10) + d(0,1,2)
    5. F(a,b,c,d) = Σ(1, 9, 10) + d(0,8,11,12)
    6. F(a,b,c,d) = π(1, 9, 10) + d(0,8,11,12)
    7. F(a,b,c,d) = Σ(0, 1, 2,3,4,5,6,7,8,9) + d(10,11,12,13,14)
    8. F(a,b,c,d) = Σ(0, 1, 2,3,4,5,6,7,8,9) + d(10,11,12,13,14,15)
    9. F(a,b,c,d) = Σ( ) + d(4,5,9)
    10. F(a,b,c,d) = Σ( ) + d( )

K Map Scenario Based Practice Problems

*For all problems, if you are asked to draw the circuit, you will need to draw the circuit too.

Question 1

In planet Z, there have been two new discoveries of Condition A and Condition B in plants. You have been tasked with creating a system which will detect the chances of development of Conditions A and B in plants. The conditions depend on the following factors:

Inputs (Factors) :

W: High Temperature. (W=1 if the temperature is high, W=0 otherwise)
X: Oxygen Level (X=1 if oxygen level is normal, X=0 otherwise)
Y: Presence of UV Light (Y=1 if UV light is present, Y=0 otherwise)
Z :Humidity (Z= 1 if the humidity is high, Z=0 otherwise)

Outputs: A : Condition A
B : Condition B

1. A plant will develop Condition A if **presence of UV Light** is accompanied by
   i) **a high temperature with normal oxygen level**
   or
   ii) **low humidity.**

2. If **UV Light is absent** then the plant will develop Condition A if there is
   i) **an abnormal level of oxygen**
   or
   ii) **there is high humidity with low temperature**

3. If the **oxygen level is not normal** or **there is high humidity with low temperature** then the plant will develop Condition B.

Devise a truth table for the system above which will detect the presence of the conditions based on the given factors. In your truth table, the input columns should be in the order WXYZ, where W is the MSB and Z is the LSB.

Draw K-map (s) based on the scenario above and derive simplified output (s).

Question 2

A new bizarre coffee machine has two LED lights, RED and GREEN which light up based on certain inputs. You are asked to derive the internal circuit of the machine which enables the lights to glow. Depending on the inputs both the lights, any one of the lights or none of the lights may glow.

Inputs (Symptoms) :

W: Water Temperature. (W=1 if the water temperature is high, W=0 otherwise)
X: Amount of coffee beans (X=1 if sufficient amount of coffee beans is present, X=0 otherwise)
Y: Presence of Milk (Y=1 if milk is present, Y=0 otherwise)
Z :Sugar Level (Z= 1 if sugar level is normal, Z=0 otherwise)

Outputs: R : RED LED
G : GREEN LED

1. The RED LED will light up if there is **milk present** and there is
   i) **an absence of coffee beans**
   or
   ii) **normal sugar level with low water temperature.**

2. If there is **no milk** then the RED LED will still glow up if there is

   i) **normal sugar level.**
   or
   ii) **a high water temperature with an adequate amount of coffee.**

3. The GREEN LED will light up if the **sugar level is normal** or **when there is a high water temperature with sufficient amount of coffee beans present.**

Devise a truth table for the system above which will detect the presence of the diseases based on the given symptoms. **In your truth table, the input columns should be in the order WXYZ, where W is the MSB and Z is the LSB.**

Question 3

On planet Z, there have been two new outbreaks of Disease X and Disease Y. You have been tasked with creating a system which will detect the presence of Diseases X and Y. A person may have no disease or any one of the diseases or both. The presence of the diseases will depend on the following symptoms:

Inputs (Symptoms) :

A: Breathing Difficulties. (A=1 if you have breathing difficulties, A=0 otherwise)
B: Normal Body Temperature (B=1 if you have a normal body temperature, B=0 otherwise)
C: Fatigue (C=1 if you have fatigue, C=0 otherwise)
D :Loss of smell (D= 1 if the person has lost his ability of smell, D=0 otherwise)

Outputs: X : Disease X
Y : Disease Y

1. You have Disease X if your **fatigue** is accompanied by
   i) **breathing difficulties with normal body temperature**
   or
   ii) **no loss of smell.**

2. If you **don't have fatigue** then you will have Disease X if you have
   i) **an abnormal body temperature**
   or
   ii) **you have loss of smell with no breathing difficulties**

3. If you **don't have a normal body temperature** or **you have lost your sense of smell with no breathing difficulties** then you have Disease Y.

Devise a truth table for the system above which will detect the presence of the diseases based on the given symptoms. **In your truth table, the input columns should be in the order ABCD, where A is the MSB and D is the LSB.**

Draw K-map (s) based on the scenario above and derive simplified output (s).

Question 4

On planet Z, there have been two new outbreaks of Disease X and Disease Y. You have been tasked with creating a system which will detect the presence of Diseases X and Y. A person may have no disease or any one of the diseases or both. The presence of the diseases will depend on the following symptoms:

Inputs (Symptoms) :

A: Normal Breathing. (A=1 if you have normal breathing, A=0 otherwise)
B: Abnormal Body Temperature (B=1 if you have an abnormal body temperature, B=0 otherwise)
C: Fatigue (C=1 if you have fatigue, C=0 otherwise)
D :Loss of smell (D= 1 if the person has lost his ability of smell, D=0 otherwise)

Outputs: X : Disease X

1. You have Disease X if your **fatigue** is accompanied by
   i) **abnormal breathing with normal body temperature**
   or
   ii) **loss of smell.**

2. If you **don't have fatigue** then you will have Disease X if you have
   i) **an abnormal body temperature**
   or
   ii) **you have loss of smell with normal breathing**

3. If you have **fatigue** or **you have an abnormal body temperature with loss of sense of smell** then you have Disease Y.

Devise a truth table for the system above which will detect the presence of the diseases based on the given symptoms. **In your truth table, the input columns should be in the order ABCD, where A is the MSB and D is the LSB.**

Draw K-map (s) based on the scenario above and derive simplified output (s).

Question 5

In planet Z, there have been two new discoveries of Condition A and Condition B in plants. You have been tasked with creating a system which will detect the chances of development of Conditions A and B in plants. The conditions depend on the following factors:

Inputs (Symptoms) :

W: Low Temperature. (W=1 if the temperature is Low, W=0 otherwise)
X: Oxygen Level (X=1 if oxygen level is abnormal, X=0 otherwise)
Y: Presence of UV Light (Y=1 if UV light is present, Y=0 otherwise)
Z :Humidity (Z= 1 if the humidity is high, Z=0 otherwise)

Outputs: A : Condition A
B : Condition B

1. A plant will develop Condition A if **presence of UV Light** is accompanied by
   i) **high temperature with normal oxygen level**
   or
   ii) **low humidity.**

2. If **UV Light is absent** then the plant will develop Condition A if there is
   i) **an abnormal level of oxygen**
   or
   ii) **high humidity with low temperature**

3. If there is an **abnormal level of oxygen** or **UV light is present in high humidity** then the plant will develop Condition B.

Devise a truth table for the system above which will detect the presence of the conditions based on the given factors. In your truth table, the input columns should be in the order WXYZ, where W is the MSB and Z is the LSB.

Draw K-map (s) based on the scenario above and derive simplified output (s).

Question No. 6 : Rock Scissors Game

Rock-paper-scissors is a game usually played between two people, in which each player simultaneously forms one of three shapes with an outstretched hand. These shapes are "rock" (a simple fist), "paper" (a flat hand), and "scissors" (a fist with the index and middle fingers together forming a V). The game has only three possible outcomes other than a tie: a player who decides to play rock will beat another player who has chosen scissors ("rock crushes scissors") but will lose to one who has played paper ("paper covers rock"); a play of paper will lose to a play of scissors ("scissors cut paper"). This time we have decided to slightly modify the game with only two options, Rock and Scissor.

Input (4 variables)

R1= 1 indicates Player 1 has chosen ***Rock***.
S1 =0 indicates Player 1 has not chosen ***Scissor***.
R2 =0 indicates Player 2 has not chosen ***Rock***.
S2 = 1 indicates Player 2 has chosen ***Scissor***.

Output (3 variables)

P1 = 1 indicates ***Player 1 is winner***

P2 = 1 indicates ***Player 2 is winner***

D = 1 indicates ***there is a tie***

We have to consider the following points when designing the game:

i) If player 1 or player 2 has not chosen anything, there will be ***no winner nor tie***.
ii) A player cannot choose rock and scissor both at a time. This state can be considered as ***DON'T CARE.***

a) Using the above specification, prepare a truth table for the game.
b) Using 4 variable Karnaugh-Map method, derive SOP expressions for all of the three possible results.

260 Practice Sheet solve by Azmari

Convert the following binary numbers to equivalent decimal numbers.

a) $(101110001001)_2$

$= 1\times2^{11} + 0\times2^{10} + 1\times2^{9} + 1\times2^{8} + 1\times2^{7} + 0\times2^{6} + 0\times2^{5} + 0\times2^{4} + 1\times2^{3} + 0\times2^{2} + 0\times2^{1} + 1\times2^{0}$

$= (2953)_{10}$

b) $(11011.101)_2$

$= 1\times2^{4} + 1\times2^{3} + 0\times2^{2} + 1\times2^{1} + 1\times2^{0} + 1\times2^{-1} + 0\times2^{-2} + 1\times2^{-3}$

$= (27.625)_{10}$

* decimal to binary

$(4195)_{10} = (?)_2$

2	4195	
2	2097	- 1
2	1048	- 1
2	524	- 0
2	262	- 0
2	131	- 0
	65	- 1

2	65	- 1
2	32	- 1
2	16	- 0
2	8	- 0
2	4	- 0
2	2	- 0
2	1	- 0
	0	- 1

$(1000001100011)_2$

$(3785.65625)_{10} = (?)_2$

2	3785	
2	1892	- 1
2	946	- 0
2	473	- 0
2	236	- 1
2	118	- 0
2	59	- 0
2	29	- 1
2	14	- 1
2	7	- 1
2	3	- 1
2	1	- 1
	0	- 1

$(111111001001)_2$

$0.65625 \times 2 = 1.3125$

$0.3125 \times 2 = 0.625$

$0.625 \times 2 = 1.25$

$0.25 \times 2 = 0.5$

$0.5 \times 2 = 1.00$

$(0.10101)_2$

$(111111001001.10101)_2$

$(4785.150263)_{10} = (?)_2$

2 | 4785	
2 | 2392	- 1
2 | 1196	- 0
2 | 598	- 0
2 | 299	- 0
2 | 149	- 1
2 | 74	- 1
2 | 37	- 0
2 | 18	- 1
2 | 9	- 0
2 | 4	- 1
2 | 2	- 0
2 | 1	- 0
	0 - 1

$(1001010110001)_2$

$0.150263 \times 2 = 0.300526$

$0.300526 \times 2 = 0.601052$

$0.601052 \times 2 = 1.202104$

$0.202104 \times 2 = 0.404208$

$0.404208 \times 2 = 0.808416$

$0.808416 \times 2 = 1.616832$

$0.616832 \times 2 = 1.233664$

$(0.0010011)_2$

$(1001010110001.0010011)_2$

$(4123)_{10} = (?)_5$

5	4123	
5	824	- 3
5	164	- 4
5	32	- 4
5	6	- 2
5	1	- 1
	0	- 1

$(4123)_{10} = (112443)_5$

$(513)_{10} = (?)_{16}$

16	513	
16	32	- 1
16	2	- 0
	0	- 2

A - 10
B - 11
C - 12
D - 13
E - 14
F - 15

$(513)_{10} = (201)_{16}$

$(813)_{10} = (?)_9$

9	813	
9	90	- 3
9	10	- 0
9	1	- 1
	0	- 1

$= (1103)_9$

* $(29)_{12} = (?)_7$

$(29)_{12} = 2 \times 12^1 + 9 \times 12^0$

$= (33)_{10}$

7	33	
7	4 -	5 ↑
	0 -	4

$(45)_7$

$(29)_{12} = (45)_7$

* $(10110111)_5 = (?)_4$

$(10110111)_5 = 1 \times 5^7 + 0 \times 5^6 + 1 \times 5^5 + 1 \times 5^4 + 0 \times 5^3 + 1 \times 5^2 + 1 \times 5^1 + 1 \times 5^0$

$= (81906)_{10}$

4	81906	
4	20476 -	2 ↑
4	5119 -	0
4	1279 -	3
4	319 -	3
4	79 -	3
4	19 -	3
4	4 -	3
4	1 -	0
	0 -	1

$(10333302)_4$

* addition, subtraction, multiplication for the pair of following base 9 numbers.

$412 = 4\times9^2 + 1\times9^1 + 2\times9^0 = (335)_{10}$

$134 = 1\times9^2 + 3\times9^1 + 4\times9^0 = (112)_{10}$

Addition

$$\begin{array}{r} 412 \\ 134 \\ \hline (546)_9 \end{array} \Rightarrow 5\times9^2 + 4\times9^1 + 6\times9^0$$

$$= (447)_{10}$$

Subtraction

$$\begin{array}{r} 412 \\ 134 \\ \hline (267)_9 \end{array} \Rightarrow 2\times9^2 + 6\times9^1 + 7\times9^0$$

$$= (233)_{10}$$

Multiplication

$$\begin{array}{r} 412 \\ 134 \\ \hline 1748 \\ 13360 \\ 41200 \\ \hline (564087)_9 \\ 56418 \end{array}$$

$9)16(1$ $\quad 9$ $\quad 7$

$9)10(1$ $\quad 9$ $\quad 1$

$9)12(1$ $\quad 9$ $\quad 3$

$9)13(1$ $\quad 9$ $\quad 4$

$\Rightarrow 5\times9^4 + 6\times9^3 + 4\times9^2 + 10\times9^1 + 8\times9^0$

$= (37520)_{10}$

* Substract 13 from 27 in 7 bits using 2's complement number system and justify whether there is an overflow or not.

$27 - 13 = 27 + (-13)$

$27 = 11011$

$+27 = 011011$

$= 0011011$ (7 bit)

$13 = 1101$

$+13 = 01101$

$= 0001101$ (7 bit)

1110010

$+1$

$-13 = 1110011$

0011011

1110011

10001110

↳ extra

Ans : 0001110

no overflow, because we add 2 different sign number.

* Substract 45 from 98 in 12 bits using 2's complement number system and justify whether there in an overflow or not.

$98 - 45 = 98 + (-45)$

98 = 1100010

+98 = 01100010

= 000001100010 (12 bit)

45 = 101101

+45 = 0101101

= 000000101101 (12 bit)

111111010010

+1

-45 = 111111010011

000001100010

111111010011

1000000110101

↳ extra

Ans = 000000110101

no overflow

Add 13 with 27 in 6 bits using 2's comp.

13 = 1101

+13 = 01101

= 001101 (6 bit)

27 = 11011

+27 = 011011

```
  001101
  011011
 -------
  101000
```

Overflow, because we add two same sign number and got different sign number.

*Add -57 with 63 in 11 bits using 2's comp.

57 = 111001

+57 = 0111001

= 00000111001 (11 bit)

```
  11111000110
            + 1
 ------------
```

-57 = 11111000111

63 = 111111

+63 = 0111111 = 00000111111 (11 bit)

```
  111111000111
  000001111111
 ---------------
 1000000001110
```

Ans = 000000001110

no overflow

2's comp (13 bit)

a) 91 - 499

= 91 + (-499)

91 = 1011011

+91 = 0 1011011 = 0000001011011 (13 bit)

499 = 111110011

+499 = 0111110011 = 0000111110011 (13 bit)

```
  1111000001100
        +     1
 ---------------
```

-499 = 1111000001101

```
  0000001011011
  1111000001101
 ---------------
  1111001101000
```

no overflow

1's complement

91 + (-499)

91 = 1011011

+91 = 01011011 = 0000001011011 (13 bit)

499 = 111110011

+499 = 0111110011 = 0000111110011 (13 bit)

−499 = 1111000001100

```
  0000001011011
  1111000001100
---------------
  1111001100111
```

no overflow

* 2's complement / 1's comp

b) 379 + 98

379 = 101111011

+379 = 0101111011 = 0000101111011 (13 bit)

98 = 1100010

+98 = 01100010 = 0000001100010 (13 bit)

```
  0000101111011
  0000001100010
---------------
  0000111011101
```

no overflow

*

cost = $(1C2)_{16}$

$= 1\times16^2 + 12\times16^1 + 2\times16^0$

$= (450)_{10}$

? 8 GB RAM cost = $450 \times 2 = 900$

graphics cost = $(1001011\,0000)_2$

$= 1\times2^{10} + 0\times2^9 + 0\times2^8 + 1\times2^7 + 0\times2^6 + 1\times2^5$

$+ 1\times2^4 + 0\times2^3 + 0\times2^2 + 0\times2^1 + 0\times2^0$

$= (1200)_{10}$

Total = $900 + 1200 = (2100)_{10}$

$(4064)_8 = 4\times8^3 + 0\times8^2 + 6\times8^1 + 4\times8^0$

$= (2100)_{10}$

left = $2100 - 2100 = 0$

* simplify the following boolean expression to minimum number of literals :

$(A+B)(A+\bar{B})(\bar{A}+C)$

$= (AA + AB + A\bar{B} + B\bar{B})(\bar{A} + C)$

$= (A + AB + A\bar{B} + 0)(\bar{A} + C)$

$= A\bar{A} + A\bar{A}B + A\bar{A}\bar{B} + AC + ABC + A\bar{B}C$

$= 0 + 0 + 0 + AC(1+B) + A\bar{B}C$

$= AC + A\bar{B}C$

$= AC(1+\bar{B})$

$= AC$

* find the complement :

$(x' + y + z')(x' + y')(x + z')$

$= (x'yz') + (x'y') + (xz')$

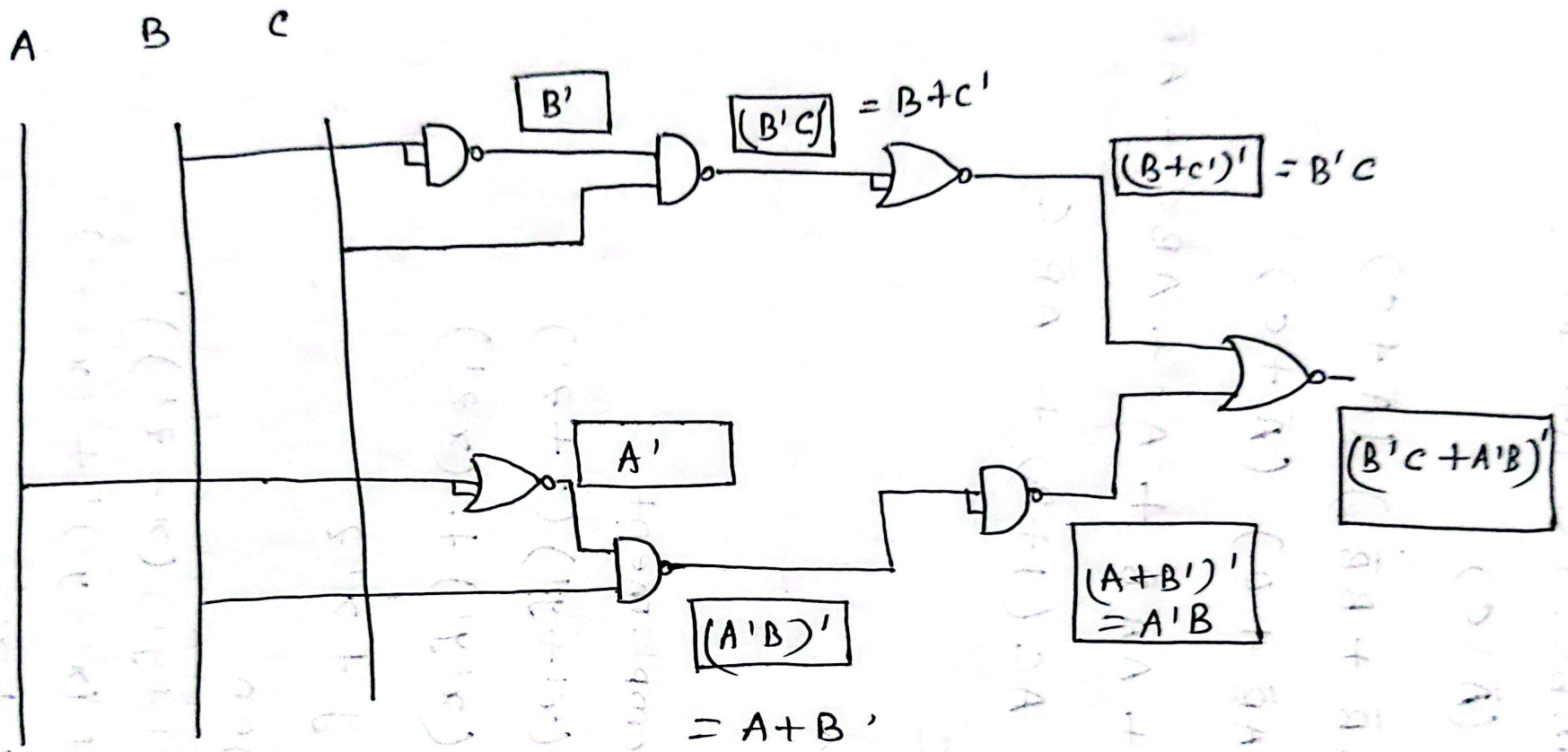
$= xy'z + xy + x'z$

Using De-morgan

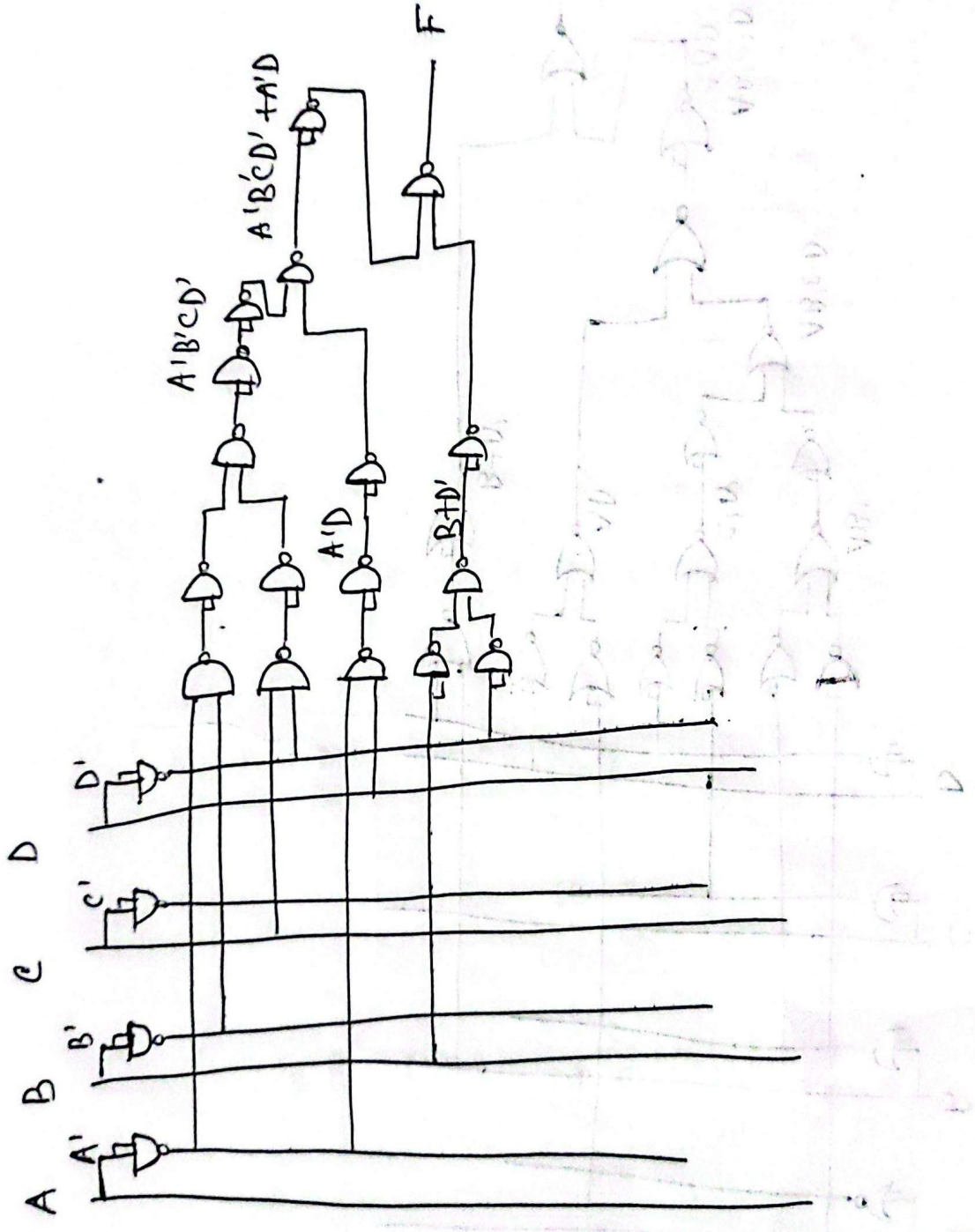
$((x' + y + z')(x' + y')(x + z'))'$

$= (x' + y + z')' + (x' + y')' + (x + z')'$

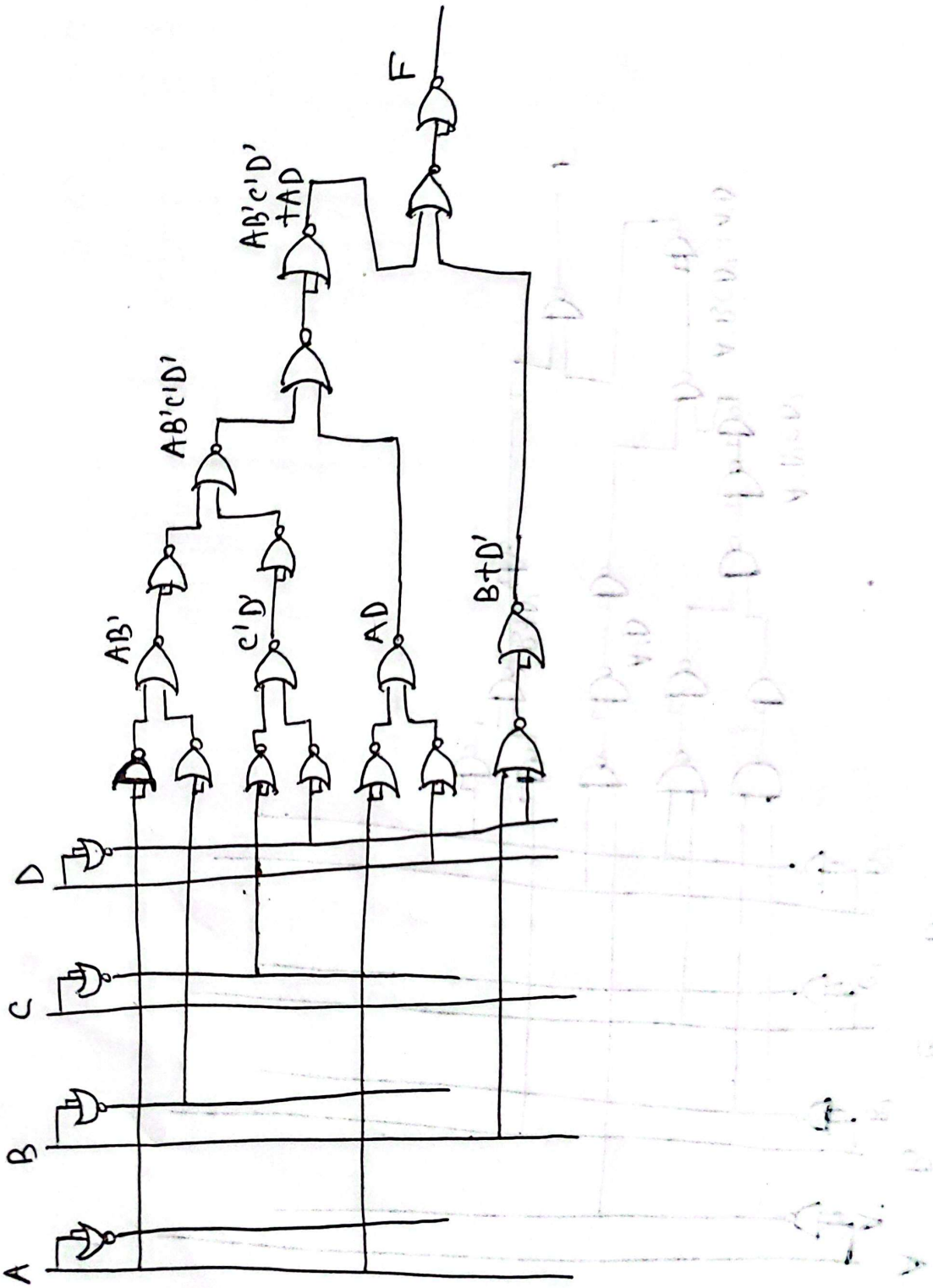
$= xy'z + xy + x'z$



NAND gate ⇒ $F(A,B,C,D) = (A'B'CD' + A'D + (B+D'))$



NOR gate ⇒ $F(A,B,C,D) = (AB'c'D' + AD + (B+D'))$



Find out SOP and POS :

1. $F(A,B,C) = AB + BC'$

$= AB(C+C') + (A+A')BC'$

$= ABC + ABC' + ABC' + A'BC'$

111 110 110 010

$= \Sigma(7, 6, 6, 2)$

$= \Sigma(2, 6, 7)$

$= \Pi(0, 1, 3, 4, 5)$

SOP → POS

$F(A, B, C) = AB + BC'$

$= (AB+B)(AB+C')$

$= AB(A+B)(B+B)(A+C')(B+C')$

$= (A+B)(B)(A+C')(B+C')$

$= (A+B+CC')(AA'+B+CC')(A+BB'+C')(AA'+B+C')$

$= (A+B+C)(A+B+C')(A+B+C)(A'+B+C')(A'+B+C)$

000 001 000 101 100

$(A+B+C')(A+B+C')(A+B'+C')(A+B+C')(A'+B+C')$

001 001 011 001 101

$= \Pi(0, 1, 0, 5, 4, 1, 1, 3, 1, 5)$

$= \Pi(0, 1, 3, 4, 5)$

② $F(A, B, C, D) = A + B'CD'$

$= A(B+B')(C+C')(D+D') + (A+A')B'CD'$

$= (AB + AB')(CD + C'D + CD' + C'D') + AB'CD' + A'B'CD'$

$= ABCD + ABC'D + ABCD' + ABC'D' + AB'CD$
1111 1101 1110 1100 1011

$+ AB'C'D + AB'CD' + AB'C'D' + AB'CD' + A'B'CD'$
1001 1010 1000 1010 0010

$= \Sigma(15, 13, 14, 12, 11, 9, 10, 8, 10, 2)$

$= \Sigma(2, 8, 9, 10, 11, 12, 13, 14, 15)$

$= \Pi(0, 1, 3, 4, 5, 6, 7)$

SOP → POS

$F(A, B, C, D) = A + B'CD'$

$= (A + B')(A + CD')$

$= (A+B')(A+C)(A+D')$

$= (A + B' + CC' + DD')(A + BB' + C + DD')(A + BB' + CC' + D)$

$= (A+B'+C+D)(A+B'+C'+D')(A+B'+C'+D)(A+B'+C+D')$
0100 0111 0110 0101

$(A+B+C+D)(A+B'+C+D')(A+B'+C+D)(A+B+C+D')$
0000 0101 0100 0001

$(A+B+C+D')(A+B'+C'+D')(A+B'+C+D')(A+B+C'+D')$
0001 0111 0101 0011

$= \Pi(4, 7, 6, 5, 0, 5, 4, 1, 1, 7, 5, 3) = \Pi(0, 1, 3, 4, 5, 6, 7)$

③ $F(A, B, C, D, E) = AB + CDE$

$= AB(C+C')(D+D')(E+E') + (A+A')(B+B')CDE$

$= (ABC + ABC')(DE + D'E + DE' + D'E') + (AB + AB' + A'B + A'B')CDE$

$= ABCDE + ABCD'E + ABCDE' + ABCD'E' + ABC'DE$
$\quad 11111 \quad 11101 \quad 11110 \quad 11100 \quad 11011$

$+ ABC'D'E + ABC'DE' + ABC'D'E' + ABCDE$
$\quad 11001 \quad 11010 \quad 11000 \quad 11111$

$+ AB'CDE + A'BCDE + A'B'CDE$
$\quad 10111 \quad 01111 \quad 00111$

$= \Sigma(31, 29, 30, 28, 27, 25, 26, 24, 31, 23, 15, 7)$

$= \Sigma(7, 15, 23, 24, 25, 26, 27, 28, 29, 30, 31)$

$= \Pi(0, 1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22)$

* $F(a,b,c,d) = \Sigma(8,9,10,11,13,15)$

1000 1001 1010 1011 1101 1111

$= ab'c'd' + ab'c'd + ab'cd' + ab'cd + abc'd + abcd$

$= ab'c'(d+d') + ab'c(d+d') + abd(c+c')$

$= ab'c' + ab'c + abd$

$= ab'(c+c') + abd$

$= ab' + abd$

$= a(b' + bd)$

$= a(b'+b)(b'+d)$

$= a(b'+d)$

SOP → POS

$F(w, x, y, z) = wy + x'z$

$= (wy + x')(wy + z)$

$= (w + x')(x' + y)(w + z)(y + z)$

$= (w + x' + yy' + zz')(ww' + x' + y + zz')(w + xx' + yy' + z$

$(ww' + xx' + y + z)$

$= (w + x' + y + z)(w + x' + y' + z')(w + x' + y' + z)(w + x' + y + z'$
0100 0111 0110 0101

$(w + x' + y + z)(w' + x' + y + z')(w' + x' + y + z)(w + x' + y + z'$
0100 1101 1100 0101

$(w + x + y + z)(w + x' + y' + z)(w + x' + y + z)(w + x + y' + z$
0000 0110 0100 0010

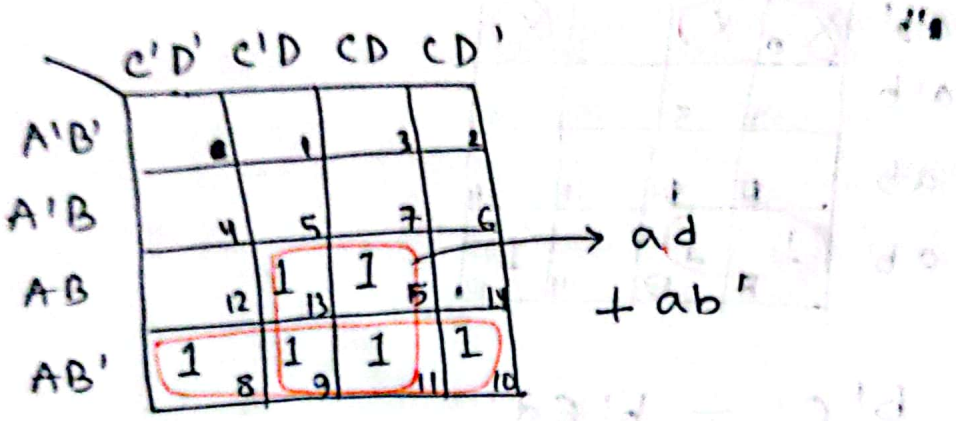
$(w + x + y + z)(w' + x' + y + z)(w' + x + y + z)(w + x' + y + z)$
0000 1100 1000 0100

$= \pi(4, 7, 6, 5, 4, 13, 12, 5, 0, 6, 4, 2, 0,$
$12, 8, 4).$

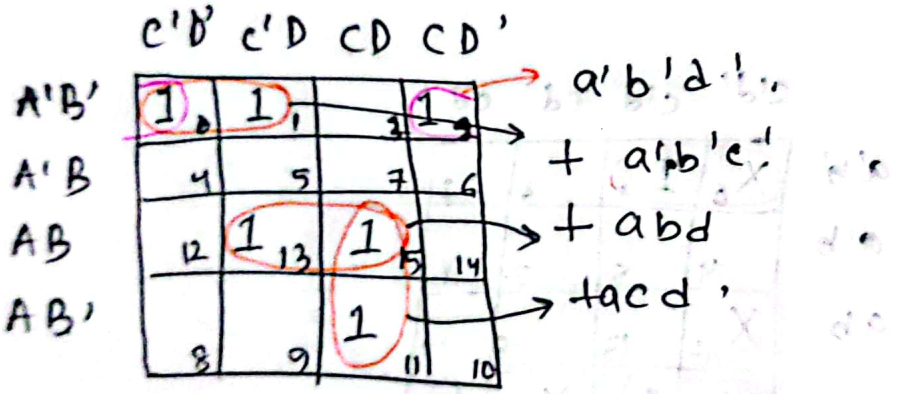
$= \pi(0, 2, 4, 5, 6, 7, 8, 12, 13)$

K-map

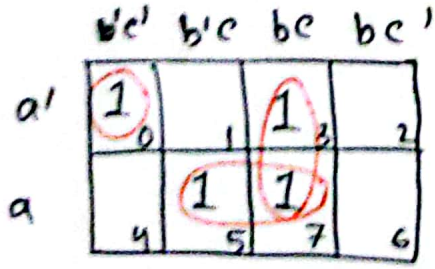
1) $F(a,b,c,d) = \Sigma(8,9,10,11,13,15)$



2) $F(a,b,c,d) = \Sigma(0,1,2,11,13,15)$

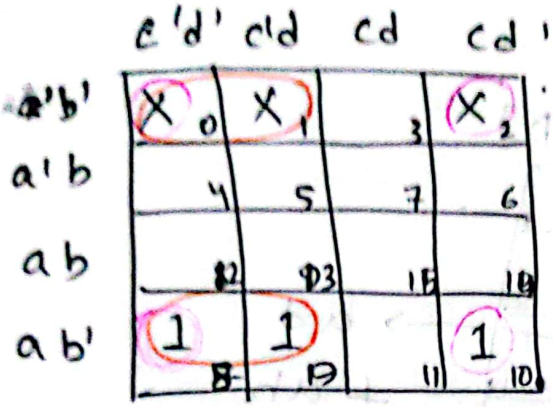


3) $F(a,b,c) = \Sigma(0,3,5,7)$



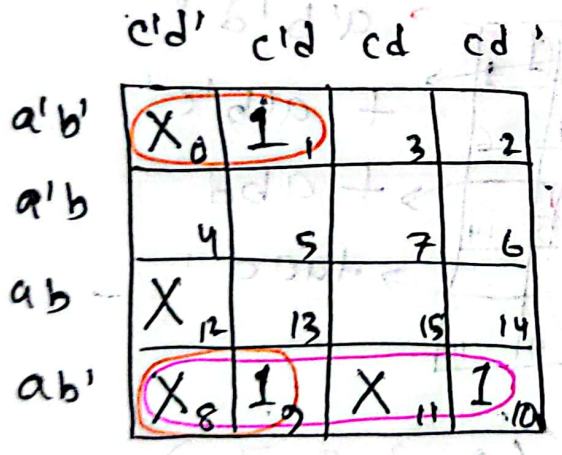
$a'b'c' + bc + ac$

4) $F(a,b,c,d) = \Sigma(8,9,10) + d(0,1,2)$



$b'c' + b'd'$

5) $F(a,b,c,d) = \Sigma(1,9,10) + d(0,8,11,12)$



$b'c' + ab'$

⑥ $F(a,b,c,d) = \pi(1,9,10) + d(0,8,11,12)$

$= \Sigma(2,3,4,5,6,7,13,14,15) + d(0,8,11,12)$

	c'd'	c'd	cd	cd'
a'b'	X 0	1	1 3	1 2
a'b	1 4	1 5	1 7	1 6
ab	X 12	1 13	1 15	1 14
ab'	X 8	9	X 11	10

$b + a'c$

⑦ $F(a,b,c,d) = \Sigma(0,1,2,3,4,5,6,7,8,9)$

$+ d(10,11,12,13,14)$

	c'd'	c'd	cd	cd'
a'b'	1 0	1 1	1 3	1 2
a'b	1 4	1 5	1 7	1 6
ab	X 12	X 13	15	X 14
ab'	1 8	1 9	X 11	X 10

$a' + c'$

(8) $F(a,b,c,d) = \Sigma(0,1,2,3,4,5,6,7,8,9) + d(10,11,12,13,14,15)$

	c'd'	c'd	cd	cd'
a'b'	1 (0)	1 (1)	1 (3)	1 (2)
a'b	1 (4)	1 (5)	1 (7)	1 (6)
ab	X (12)	X (13)	X (15)	X (14)
ab'	1 (8)	1 (9)	X (11)	X (10)

1

(9) $F(a,b,c,d) = \Sigma(\,) + d(4,5,9)$

X	X		
	X		

0

(10) $F(a,b,c,d) = \Sigma(\,) + d(\,)$

Ans : 0

K-map Scenario Based:

(1)

$A = Y(WX + Z')$

$A = Y'(X' + ZW')$

$A = WXY + YZ' + X'Y' + W'Y'Z$

$= WXY(Z+Z') + (W+W')(X+X')YZ' + (W+W')X'Y'$

$(Z+Z') + W'(X+X')Y'Z$

$= WXYZ + WXYZ' + (WX + W'X + WX' + W'X')YZ'$

$+ (WX'Y' + W'X'Y')(Z+Z') + W'XY'Z + W'XY'Z$

$= \underset{1111}{WXYZ} + \underset{1110}{WXYZ'} + \underset{1110}{WXYZ'} + \underset{0110}{W'XYZ'} + \underset{1010}{WX'YZ'}$

$+ \underset{0010}{W'X'YZ'} + \underset{1001}{WX'Y'Z} + \underset{1000}{WX'Y'Z'} + \underset{0001}{W'X'Y'Z}$

$+ \underset{0000}{W'X'Y'Z'} + \underset{0101}{W'XY'Z} + \underset{0001}{W'X'Y'Z}$

$= \Sigma(15, 14, 14, 6, 10, 2, 9, 8, 1, 0, 5, 1)$

$= \Sigma(0, 1, 2, 5, 6, 8, 9, 10, 14, 15)$

$$B = x' + zw'$$

$$= (w+w')x'(y+y')(z+z') + w'(x+x')(y+y')z$$

$$= (wx' + w'x')(yz + yz' + y'z + y'z') + (w'x + w'x')(yz + y'z)$$

$$= \underset{1011}{wx'yz} + \underset{1001}{wx'y'z} + \underset{1010}{wx'yz'} + \underset{1000}{wx'y'z'} + \underset{0011}{w'x'yz}$$
$$+ \underset{0001}{w'x'y'z} + \underset{0010}{w'x'yz'} + \underset{0000}{w'x'y'z'} + \underset{0111}{w'xyz}$$
$$+ \underset{0101}{w'xy'z} + \underset{0011}{w'x'yz} + \underset{0001}{w'x'y'z}$$

$$= \Sigma(11, 9, 10, 8, 3, 1, 2, 0, 7, 5, 3, 1)$$

$$= \Sigma(0, 1, 2, 3, 5, 7, 8, 9, 10, 11)$$

minterm	W	X	Y	Z	A	B
0	0	0	0	0	1	1
1	0	0	0	1	1	1
2	0	0	1	0	1	1
3	0	0	1	1	0	1
4	0	1	0	0	0	0
5	0	1	0	1	1	1
6	0	1	1	0	1	0
7	0	1	1	1	0	1
8	1	0	0	0	1	1
9	1	0	0	1	1	1
10	1	0	1	0	1	1
11	1	0	1	1	0	1
12	1	1	0	0	0	0
13	1	1	0	1	0	0
14	1	1	1	0	1	0
15	1	1	1	1	1	0

(2)

$R = Y(X' + ZW')$

$R = Y'(Z + WX)$

$R = X'Y + W'YZ + Y'Z + WXY'$

$= (W+W')X'Y(Z+Z') + W'(X+X')YZ + (W+W')(X+X')Y'Z + WXY'(Z+Z')$

$= (WX'Y + W'X'Y)(Z+Z') + W'XYZ + W'X'YZ + WXY'Z + WX'Y'Z + W'XY'Z + WXY'Z'$

$= WX'YZ + W'X'YZ + WXY'Z' + W'X'YZ' + W'XYZ + W'X'YZ + WX'Y'Z + W'XY'Z + W'X'Y'Z + WXY'Z + WXY'Z'$

1011 0011 1010 0010 0111 0011 1101 1001 0101 0001 1101 1100

$= \Sigma(11, 3, 10, 2, 7, 3, 13, 9, 5, 1, 13, 12)$

$= \Sigma(1, 2, 3, 5, 7, 9, 10, 11, 12, 13)$

$G = z + wx$

$= (w+w')(x+x')(y+y')z + wx(y+y')(z+z')$

$= (wx + wx' + w'x + w'x')(yz + y'z) + wx(yz + yz' + y'z + y'z')$

$= wxyz + w'xyz + wx'yz + w'x'yz + wxy'z$
(1111) (0111) (1011) (0011) (1101)

$+ w'xy'z + wx'y'z + w'x'y'z + wxyz$
(0101) (1001) (0001) (1111)

$+ wxy'z + wxyz' + wxy'z'$
(1101) (1110) (1100)

$= \Sigma(15, 7, 11, 3, 13, 5, 9, 1, 15, 13, 14, 12)$

$= \Sigma(1, 3, 5, 7, 9, 11, 12, 13, 14, 15)$

③ $X = C(AB + D')$

$X = C'(B' + DA')$

$X = ABC + CD' + B'C' + A'C'D$

$= ABC(D+D') + (A+A')(B+B')CD' + (A+A')B'C'(D+D') + A'(B+B')C'D$

$= ABCD + ABCD' + (AB + A'B + AB' + A'B')CD' + (AB'C' + A'B'C')(D+D') + A'BC'D + A'B'C'D$

$= ABCD + ABCD' + ABCD' + A'BCD' + AB'CD' + A'B'CD' + AB'C'D + AB'C'D' + A'B'C'D + A'B'C'D' + A'BC'D + A'B'C'D$

1111 1110 1110 0110 1010 0010 1001 1000 0001 0000 0101 0001

$= \Sigma(15, 14, 14, 6, 10, 2, 9, 8, 1, 0, 5, 1)$

$= \Sigma(0, 1, 2, 5, 6, 8, 9, 10, 14, 15)$

$Y = B' + A'D$

$= (A+A')B'(C+C')(D+D') + A'(B+B')(C+C')D$

$= (AB' + A'B')(CD + C'D + CD' + C'D') + (A'B + A'B')(CD + C'D)$

$= AB'CD + AB'C'D + AB'CD' + AB'C'D'$
$\quad 1011 \quad 1001 \quad 1010 \quad 1000$

$+ A'B'CD + A'B'C'D + A'B'CD' + A'B'C'D'$
$\quad 0011 \quad 0001 \quad 0010 \quad 0000$

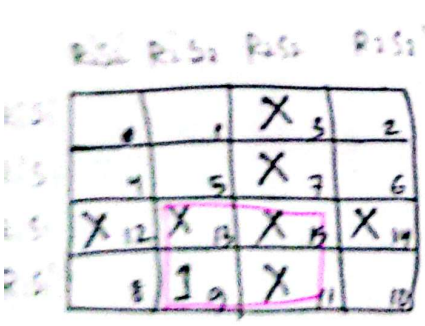
$+ A'BCD + A'BC'D + A'B'CD + A'B'C'D$
$\quad 0111 \quad 0101 \quad 0011 \quad 0001$

$= \Sigma (11, 9, 10, 8, 3, 1, 2, 0, 7, 5, 3, 1)$

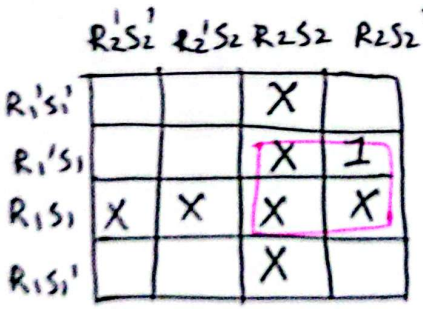
$= \Sigma (0, 1, 2, 3, 5, 7, 8, 9, 10, 11)$

(6)

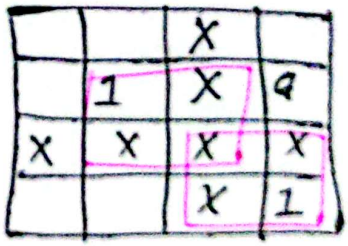
	R1	S1	R2	S2	P1	P2	D
0	0	0	0	0	0	0	0
1	0	0	0	1	0	0	0
2	0	0	1	0	0	0	0
3	0	0	1	1	X	X	X
4	0	1	0	0	0	0	0
5	0	1	0	1	0	0	1
6	0	1	1	0	0	1	0
7	0	1	1	1	X	X	X
8	1	0	0	0	0	0	0
9	1	0	0	1	1	0	0
10	1	0	1	0	0	0	1
11	1	0	1	1	X	X	X
12	1	1	0	0	X	X	X
13	1	1	0	1	X	X	X
14	1	1	1	0	X	X	X
15	1	1	1	1	X	X	X



P1 = R1S2



P2 = R2S1



D = S1S2 + R1R2