* Digital Systems الأنظمة الرقمية

1. Decimal Base 10 النظام العشري → (109)
2. Binary Base 2 النظام الثنائي → $(1010)_2$
3. Octal Base 8 النظام الثماني → $(177)_8$
4. Hexa-Decimal Base 16 النظام السادس عشر → $(1AB)_{16}$

* Conversion التحويل

1. التحويل من Decimal
   - Binary
   - Octal
   - Hexa-Decimal

* طريقة التحويل من Decimal لباقي الأنظمة عن طريق القسمة

1. $(40)_{10} = (101000)_2$

40	2
20	0
10	0
5	0
2	1
1	0
0	1

الكتابة مأخوذة لفوق

2. $(40)_{10} = (50)_8$

40	8
5	0
0	5

3. $(40)_{10} = (28)_{16}$

40	16
2	8
0	2

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2

التحويل من

Binary
octal
Hexa-Decimal
→ Decimal

* الطريقة للتحويل من باقي الأنظمة لل Decimal يعتمد على الضرب

1 $(10101)_2 = (\ 21\ )_{10}$

$2^4\ 2^3\ 2^2\ 2^1\ 2^0$
16 8 4 2 1

$1*2^0 + 0*2^1 + 1*2^2 + 0*2^3 + 1*2^4$

$1 + 0 + 4 + 0 + 16 = 21$

2 $(35)_8 = (\ 29\ )_{10}$

$8^1\ \ 8^0$

$5*8^0 + 3*8^1$

$5 + 24 = 29$

3 $(A04)_{16} = (\ 2564\ )_{10}$

$16^2\ \ 16^1\ \ 16^0$

$4*16^0 + 0 + 10*16^2$

$4 + 0 + 2560$

في حال عندي فاصلة عشرية

1 $(11.01)_2 = (\ 3.25\ )_{10}$

$2^1\ \ 2^0\ \ 2^{-1}\ \ 2^{-2}$

$1*2^0 + 1*2^1 + 0*2^{-1} + 1*2^{-2}$

$1 + 2 + 0 + \frac{1}{4} = 0.25$

$3 + 0.25$

[redacted]

2 $(3.4)_8 = (\ 3.5\ )_{10}$

$8^0\ \ 8^{-1}$

$3*8^0 + 4*8^{-1}$

$3 + \frac{4}{8} = \frac{1}{2} = 0.5$

3 $(0.25)_2 = (0.01)_{10}$

$0.25 * 2 = 0.5$ → 0 باخذ بعد الفاصلة

$0.5 * 2 = 1$ → 0 صون ماعندي كسر — ننزل الكسر تحت

* اذا كان عندي Decimal وكسور

- كل انه بجيب الرقم اللي بدي احوله وبضربه بالأساس اللي بده أصون انه

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[4] Binary ⇄ oct [3] Binary ⇄ Hex التحويل من

[3] Hex ⇄ Binary ⇄ Octal

	Binary (4 digits
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000

	Binary (4 Digits)
9	1001
(A)10	1010
(B)11	1011
(C)12	1100
(D)13	1101
(E)14	1110
(F)15	1111

[1] $(A1)_{16} = (1010\ 0001)_2$
1010 0001

[2] $(43F1)_{16} = (0100\ 0011\ 1111\ 0001)_2$
0100 0011 1111 0001

[3] $(01100101)_2 = (65)_{16}$
6 5
باخد 4 خانات التحويل Hex

[4] $(11100)_2 = (1C)_{16}$
لما مايكون عندي 4 خانات بحط الباقي 0

Octal → Binary
3 digits only

[1] $(37)_8 = (011\ 111)_2$
011 111

[2] $(14)_8 = (001\ 100)_2$
001 100

[3] $(111011)_2 = (73)_8$
7 3
مناضل

[4] $(010010)_2 = (22)_8$
2 2
بحطهم مشان يطلعوا 3

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5 $(A53)_{16} = (5123)_8$

1010 0101 0011

$(A53)_{16} \rightarrow (1010\ 0101\ 0011)_2$

5 1 2 3

للتحويل من نظام Hexa لنظام Octal

1 حول من Hexa لـ Binary

2 حول من Binary لـ octal

---

* Complements

1 1's Complement

2 2' complement

where do we use Complement?

$X - Y \equiv X + -(Y)$

1 1's Complement

$1 \rightarrow 0$

$0 \rightarrow 1$

Q) 10010 1's Complement?

01101

2 2's Complement

Complement 1's لكونفن ال

ولكن بمزيد 1

Q) 10010 2's Complement?

1 1's complement 01110

01101

2 01101 +1

01110

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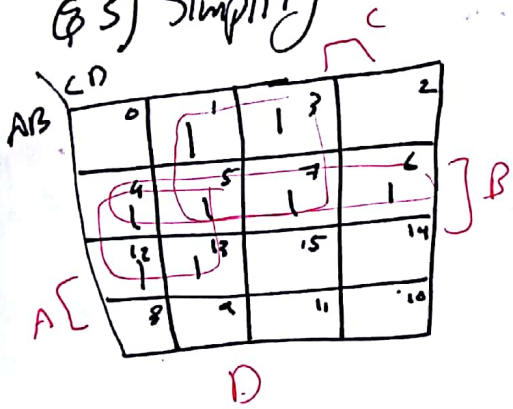
4) Convert $(\underbrace{1001}_{9}\underbrace{0000}_{0}\underbrace{1000}_{8})_{BCD} = (111000110)_2$??

1001 0000 1000 = 908 decimal

908	2
454	0
227	1
113	1
56	0
28	0
14	0
7	1
3	1
1	1
0	

5) Simplify



$\bar{A}\cdot D + B\bar{A}B + B\bar{C}$

$F = \bar{A}D + \bar{A}B + B\bar{C}$

6) $f(A,B,C) = \sum m(1,3,4,5,7)$, What is the POS function?

if $\sum m(1,3,4,5,7)$ then $\prod M(0,2,6)$

$POS = (A+B+C)\cdot(A+\bar{B}+C)\cdot(\bar{A}+\bar{B}+C)$

First = $M_0 = A+B+C$ (000)

$M_2 = A+\bar{B}+C$ (010)

$M_6 = \bar{A}+\bar{B}+C$ (110)

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* Past Papers :-

1) Simplify the function:

$$F(x,y,z,w,u) = (x+y+z) + \overline{(x+y+z)} \cdot (w+u)$$

Sol

let $R = x+y+z$

$$f = R + \bar{R} \cdot (w+u)$$

$$(R+\bar{R}) \cdot (R+w+u)$$

$$f = x+y+z+w+u$$

---

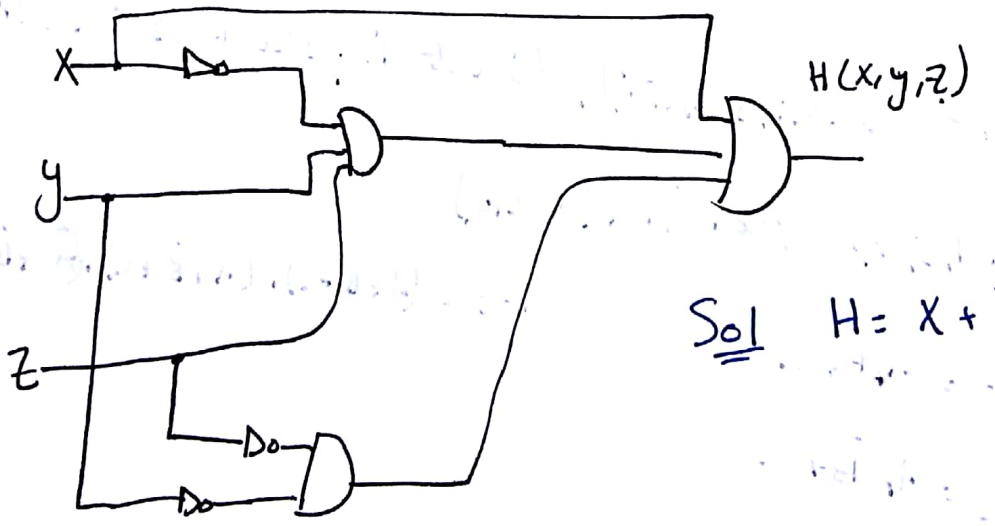
2) Convert $(1100\,1111 \cdot 1010)_2$ to (CF.A)h

12 15

C F . A

---

3) What is the output of this circuit?



Sol $H = X + \bar{x}yz + \bar{y}\bar{z}$

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[*] Addition

Q) $(1101)_2 + (1010)_2 = (10111)$

```
   1101  +
   1010
 [1]----
  10111
```

Q) $(A1)_{16} + (F2)_{16} = (193)$

طريقة ثانية

```
10  ← A1   +
15+ ← F2
--   -----
25    193
```

هاي عندي بال Decimal لازم احولها Hex.

```
25 | 16
 1 |  9
 0 |  1
```

```
 A1  +
 F2
----
193
```

حولها Binary

```
(1) 1010 0001  +
    1111 0010
 --------------
0001 1001 0011
   1    9    3
```

حولها Hex

Q) $(10)_8 + (27)_8 = (37)$

```
10  +
27
--
37
```

```
001 000  +
010 111
-------
011 111
  3   7
```

---

[*] Subtraction

Q) 1010100 − 1000011 = ? using 2's Complement.

```
1010100  -
1000011   →  2's complement
-------
```

اللي عنده الإشارة السالبة بستعمله

2's

```
1000011
0111100
      1 +
-------
0111101
```

```
  1010100
(1)0111101  +
---------
  0010001
```

carry x

= 0010001

اكون عندي

ال carry نشطبه ونبقي عند الاجابة

Ave

Q) 7 - 13 = ?

using 1's complement

7 → 0111

13 → 1101 → 1's complement → 0010

7 − 13 = −6

0111
0010 +
1001

carry = 0 → −ve

1's complement of 1001

1001
0110

−ve 6

Subtraction

1's

Carry
- the answer is +ve
- add the carry to the answer.

No carry
- the answer is −ve
- take the 1's complement to the answer.

2's

Carry
- the answer is +ve
- delete the carry (don't add it)

No carry
- the answer is −ve
- take the 2's complement to the answer

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* BCD: Binary - Coded - Decimal

Code لكود Decimal رقم
Binary بال

0 - 9
0000 - 1001

ex) $(185)_{10} = (0001\ 1000\ 0101)_{BCD}$ Binaly لاضه كل خانة وتحويلها

* BCD Addition:-

ex) 105 + 87 = ? 192

105 →	0001	0000	0101	
87 →	0000	1000	0111	+
	0001	1001	1100	
			0110	+
			0010	
	1	9	2	

جمنا 6

BCD if # > 9 we add +6
10, 11, 12, 13, 14, 15, 16, 17, 18, 19

6 = Hex9 لانه الفرق بين Decimal و

* Boolean Algebra and logic gates :-

- X : 0, 1
- And (·), OR (+), Not $\bar{X}$

X	y	X·y	X+y	$\bar{X}$
0	0	0	0	1
0	1	0	1	1
1	0	0	1	0
1	1	1	1	0

And both x, y = 1 مشان الـ answer يكون 1

OR atleast on x, y = 1 مشان الـ answer يكون 1

- $X \cdot 0 = 0$
- $X \cdot 1 = X$
- $X + 0 = X$
- $X + 1 = 1$
- $X \cdot \bar{X} = 0$
- $X + \bar{X} = 1$
- $X + yz = (x+y)(x+z)$
- $X(y+z) = xy + xz$

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* Demorgan's :

$$\overline{xy} = \bar{x} + \bar{y}$$

$$\overline{x+y} = \bar{x} \cdot \bar{y}$$

---

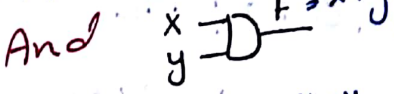
* Boolean function

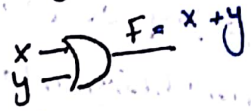
$$F = x + \bar{y} \cdot z$$

Truth table

x	y	z	F
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

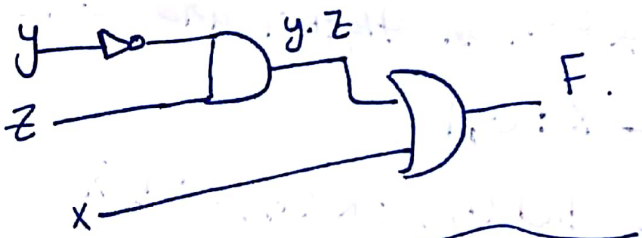
* Implementation with gates

And 

OR 

Not 

الأولويات
1- (أقواس)
2- Not
3- AND
4- OR



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* Simplify

1) $x(\bar{x}+y)$

$x \cdot \bar{x} + xy$

$0 + xy = xy$

2) $x + \bar{x}y$

$(x+\bar{x})(x+y)$

$1 * (x+y) = x+y$

* Complement of a function

1) $\bar{x}y\bar{z} + \bar{x}\bar{y}z = F_1$ $\quad \bar{F}_1 = ?$

تكتب الـ function

$\bar{x}y\bar{z} + \bar{x}\bar{y}z$

$\overline{\bar{x}y\bar{z}} \cdot \overline{\bar{x}\bar{y}z}$

$(x + \bar{y} + z) \cdot (x + y + \bar{z})$

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* Boolean Expression

Sum of product Minterm SOP

$x=1$, $\bar{x}=0$

$f = xyz + \bar{x}yz + \bar{x}\bar{y}\bar{z} \dots$

$m_7 \quad m_3 \quad m_0$

$f = \sum(m_7, m_3, m_0)$

$f = \sum_m(0,3,7)$

Product of sum Maxterm POS

$x=1$, $\bar{x}=0$

$f = (\bar{x}+y+\bar{z})(x+y+z)(\bar{x}+\bar{y}+\bar{z})$

$M_5 \quad M_0 \quad M_7$

$f = \Pi(M_0, M_5, M_7)$

$f = \Pi_M(0,5,7)$

* ملاحظات:-

١- احدد اني بنظر OR بال SOP اذا كانت تحوي كل جميع المتغيرات فقط SOM

٢- كمان اني بنظر and بال POS اذا كانت تحوي كل جميع المتغيرات فقط تعتبر POM

* الترتيب مهم بالي بعطيني اياه بالسؤال

Q) express the following function in SOP and POS form?

$F = X + yz$

SOP

$F = X + yz$

ناقصة y, z — ناقصة x

$f = X \cdot 1 + yz \cdot 1$

$= x(y+\bar{y})(z+\bar{z}) + yz(x+\bar{x})$

$xyz + xy\bar{z} + x\bar{y}z + x\bar{y}\bar{z} + \cancel{xyz} + \bar{x}yz$

الاشي اكرر مخذف

$xyz + xy\bar{z} + x\bar{y}z + x\bar{y}\bar{z} + \bar{x}yz$

POS

$f = X + yz$

لازم احوله للشكل العام $(x+\ )(x+\ )$

خاصية التوزيع

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

ناقصه z — ناقصه y

$((x+y)+0)((x+z)+0)$

$((x+y)+z\bar{z})((x+z)+y\bar{y})$

$(x+y+z)\cdot(x+y+\bar{z})\cdot(x+\cancel{y}+z)\cdot(x+\bar{y}+z)$

الاشي اكرر مخذف

$(x+y+z)\cdot(x+y+\bar{z})\cdot(x+\bar{y}+z)$

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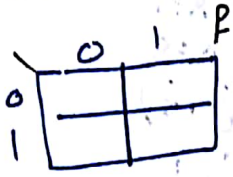
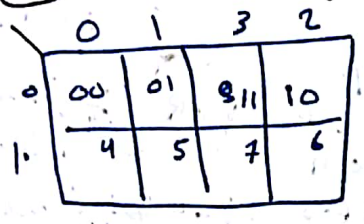
* k-map

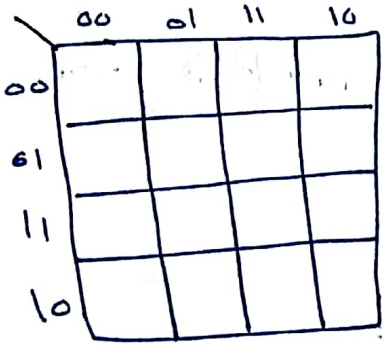
1 2-Var k-map



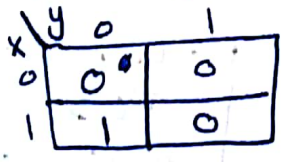
2 3-Var k-map



3 4-Var k-Map

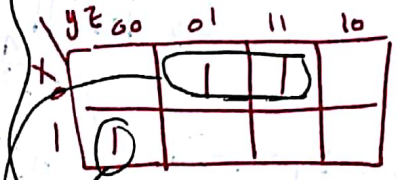


Q) $F = x\bar{y}$ ... fill the k Map?



x	y	F
0	0	0
0	1	0
1	0	1
1	1	0

Q) find the $f(x,y,z)$?



لازم آخذ الـ 1 بكل شكل تجموعات وبكونوا جنبا بعضن بشكل أفقي أو عمودي فقط وعددهم متاضاعفات 2

$f(x,y,z) =$

$\bar{x}\bar{y}z$

$\bar{x}yz$

طريقة 1 ⇒ $\bar{x}\bar{y}z + \bar{x}yz = \bar{x}z(y+\bar{y})$

$= \bar{x}z + z\bar{y}$

طريقة 2.

أول	x	y	z
1	0	0	1
	0	1	1

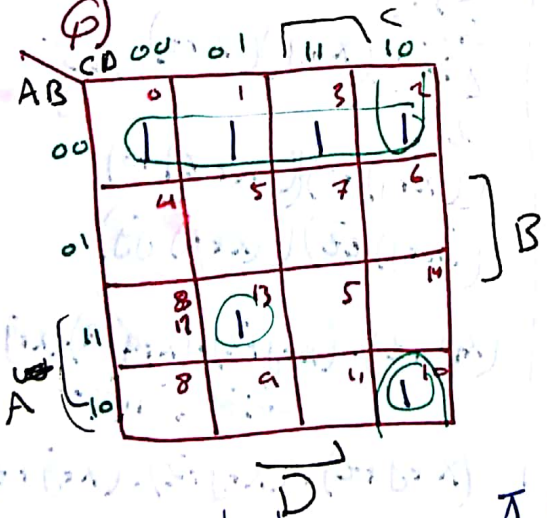
ثاني: $z\bar{y}$ (x)

SOP

لأنه شوف الـ 1.

$f(A,B,C,D) = \sum(0,1,2,3,10,13)$

Q)



4 variable maps can have rectangles corresponding to:

1. a single 1 → 4 variables
2. two ones → 3 variables
3. 4 ones → 2 variables
4. 8 ones → 1 variable
5. 16 ones → 0 variables

function of all ones

$\bar{A}\bar{B} + AB\bar{C}D + \bar{B}C\bar{D}$

A	B	C	D
0	0	0	0
0	0	0	
0	0		
0			

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* Simplify

Q) $ABC + \bar{A}B + AB\bar{C}$

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

$AB + \bar{A}B$

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

B

Q) $xy\bar{z} + \bar{x}yz + xyz + \bar{x}y\bar{z}$

$xy(z+\bar{z}) + \bar{x}yz + \bar{x}y\bar{z}$

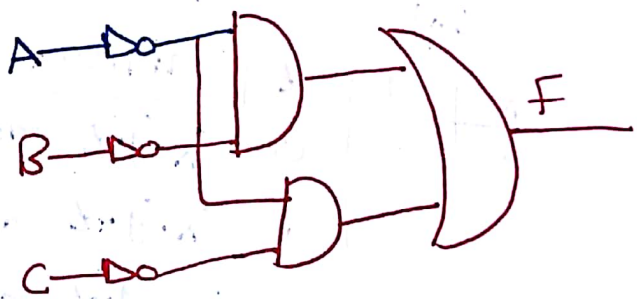
$xy + \bar{x}y(z+\bar{z})$

$xy + \bar{x}y$

$y(x+\bar{x}) = y$

Q) Simplify and draw logic Diagram.

A	B	C	F
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	0



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

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

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

$\bar{A}(\bar{B} + B\bar{C})$ → تجزئ على قاعدة التوزيع

$\bar{A}([\bar{B}+B] \cdot [\bar{B}+\bar{C}])$

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

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

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* Canonical and Standard form :-

↳ الصورة القياسية

↳ $f(x,y,z) = xyz + \bar{x}yz + x\bar{y}z$ ---- كل term يحتوي على جميع المركبات

* Minterm :- الحد الذي يعطي 1 عند تعويضه في المعادلة

* Maxterm :- الحد الذي يعطي 0 عند تعويضه في المعادلة

Minterm	Maxterm
1 ← x في المعادلة 0 ← $\bar{x}$ (.) الحدود بينهما Syntax: $x.y.z$	0 ← x في المعادلة 1 ← $\bar{x}$ (+) الحدود بينهما Syntax: $\bar{x}+\bar{y}+\bar{z}$

Ex)

x	y	z	Minterm	Maxterm
0	0	0	$\bar{x}.\bar{y}.\bar{z}$ m_0	$x+y+z$ M_0
0	0	1	$\bar{x}.\bar{y}.z$ m_1	$x+y+\bar{z}$ M_1
0	1	0	$\bar{x}.y.\bar{z}$ m_2	$x+\bar{y}+z$ M_2
0	1	1	$\bar{x}.y.z$ m_3	$x+\bar{y}+\bar{z}$ M_3
1	0	0	$x.\bar{y}.\bar{z}$ m_4	$\bar{x}+y+z$ M_4
1	0	1	$x.\bar{y}.z$ m_5	$\bar{x}+y+\bar{z}$ M_5
1	1	0	$x.y.\bar{z}$ m_6	$\bar{x}+\bar{y}+z$ M_6
1	1	1	$x.y.z$ m_7	$\bar{x}+\bar{y}+\bar{z}$ M_7

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* Decoders

→ Input n → Binary

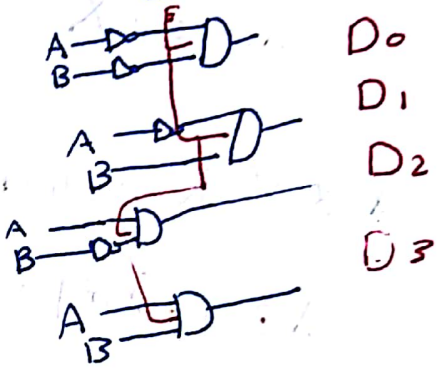
→ output 2^n → decimal.

2-4 decoder

1- truth table.

A	B	D_3	D_2	D_1	D_0
0	0	0	0	0	1
0	1	0	0	1	0
1	0	0	1	0	0
1	1	1	0	0	0

- circuit.

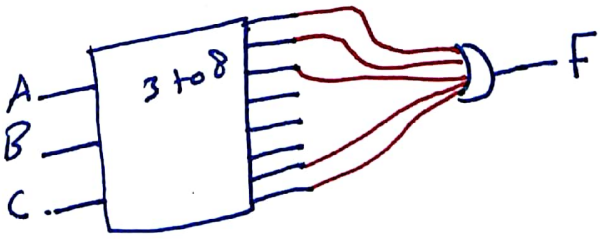


we should add Enable to the decoder

A	B	E	D_3	D_2	D_1	D_0
X	X	0	0	0	0	0
0	0	1	0	0	0	1
0	1	1	0	0	1	0
1	0	1	0	1	0	0
1	1	1	1	0	0	0

Q) Implement $f = \Sigma(0,1,2,6,7)$ using 3 to 8 decoder.

	A	B	C	F
0				1
1				1
2				1
3				0
4				0
5				0
6				1
7				1



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*Exclusive OR / Exclusive NOR

* XOR = odd

$X \oplus y = X\bar{y} + \bar{X}y$

$X \oplus 0 = X$

$X \oplus 1 = \bar{X}$

$X \oplus X = 0$

$X \oplus \bar{X} = 1$

* XNOR = even

$X \odot y = \overline{X \oplus y} = Xy + \bar{X}\bar{y}$

$X \odot 0 = \bar{X}$

$X \odot 1 = X$

$X \odot X = 1$

$X \odot \bar{X} = 0$

$X \odot y = y \odot X$

$X \odot (X \odot Z) = (X \odot y) \odot Z$

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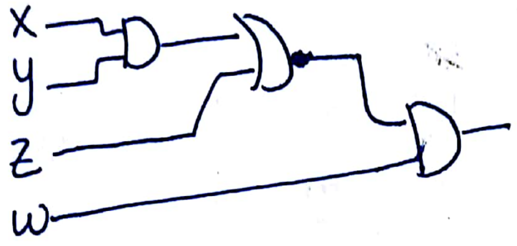
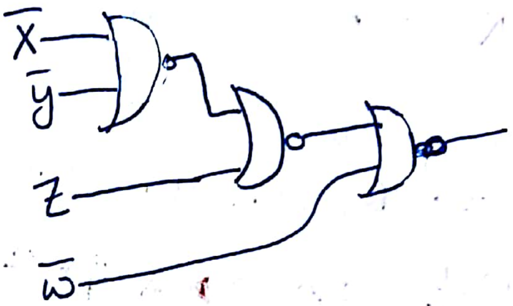
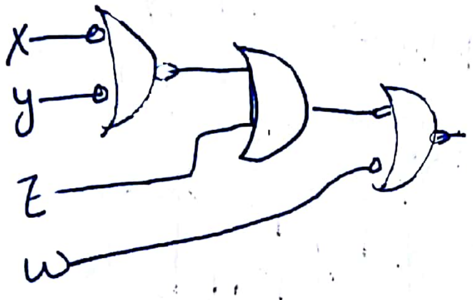
Q) Implement the following function using NOR Gates only.

$f(x,y,z,w) = (xy + z) \cdot w$



final answer.





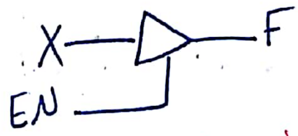
* Buffer

$S = x$

x	S
0	0
1	1

the output is the same as the input

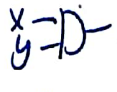
Tri-state Buffer



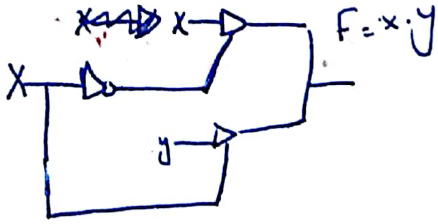
EN	X	F
0	0	Z
0	1	Z
1	0	0
1	1	1

مبدأ عملها: هناك سلك اضافي متحكم اسمه Enable هذا السلك اذا حملت عليه قيمة 0 لا يسمح للgate بالعمل أي أنها تصبح غير موجودة أما اذا دخل 1 تعمل Buffer

Build AND gate by using Tri state Buffers AND Invertors.



x	y	x.y
0	0	0
0	1	0
1	0	0
1	1	1



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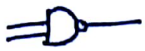
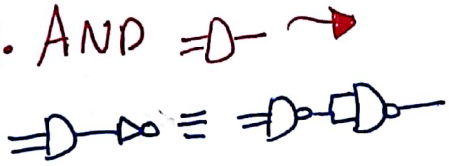
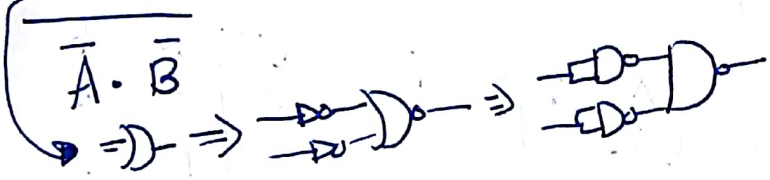
* other gates type

- universal gates
  - ~~[illegible]~~
  - NAND
  - NOR

*NAND 
*NOR 

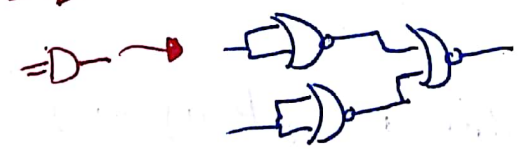
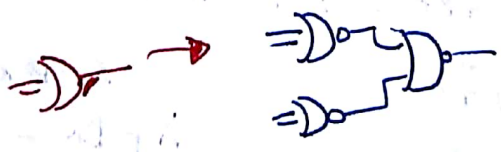
* How to invert Not, AND, NOR using NAND?

1. Not 
2. AND 
3. OR $\overline{\overline{A+B}}$

$\overline{A} \cdot \overline{B}$ 

* How to invert

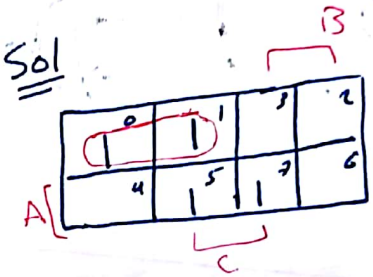
~~[illegible]~~ Not, AND, OR using NOR?

1. Not 
2. AND 
3. OR 

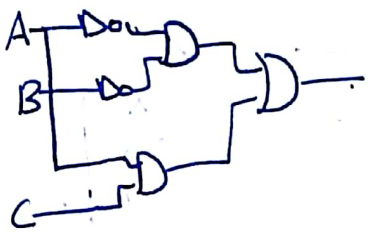
Q) Implement the following function using NAND gate only:

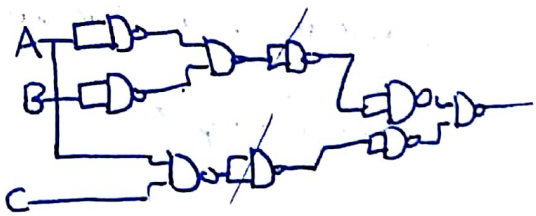
$F(A,B,C) = \sum m(0,1,5,7)$

Sol

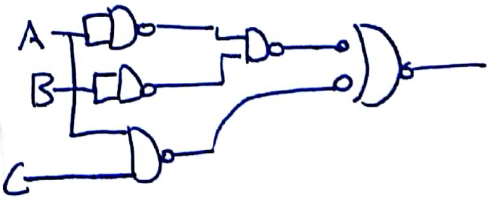


$\overline{A}\overline{B} + AC$





final answer



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How to find

1. literal cost
2. gate input cost (L)
3. gate input cost (G)
   with inverter (GN)

1. literal cost → count the number of letters in the function

2. gate input cost → the sum of literal cost with the number of margins

3. gate input cost with inverter → the sum of G with the number of inverters

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*Parity Code ch.2

↘ adding a bit the number we have to make the number of 1's either even or odd

1) (1001)
- even 10010 P.b
- odd 10011

2) 0111
- even 01111
- odd 01110

SOP & Som, POS & PoM ch.2

- Sum of minterms Som
- Sum of products - SoP

1- نحول الـ Function اللي معطيني ياه بالسؤال إلى SoP

2- نتفقد كل حد ومعرفة الـ Var الناقصة في كل حد

3- اضافة الـ Var الناقصة بشكل R+R̄

4- نوزع الضرب على الجمع

5- اذا تكرر حد نفسه أكثر من مرة (مرتين) نأخذ حد واحد فقط

- Product of sum
- Product of Maxterms

1- نحول الـ Function اللي معطيني ياه بالسؤال إلى POS

2- نتفقد كل حد ومعرفة الـ Var الناقصة في كل حد

3- اضافة الـ Var الناقصة بشكل R.R̄

4- نوزع الجمع على الضرب

5- اذا تكرر حد نفسه أكثر من مرة (مرتين) نأخذ حد واحد فقط

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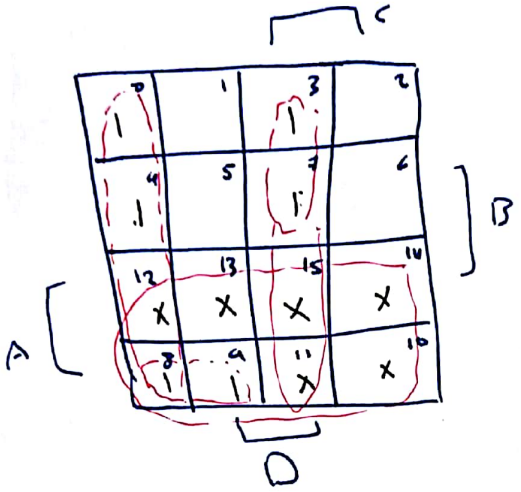
* Don't Care (X) → Kmaps

0 ఇస్తుంది
1 ఇస్తుంది

Q) $F(A,B,C,D) = \Sigma(0,3,4,7,8,9)$

$D(A,B,C,D) = \Sigma(10,11,12,13,14,15)$



$F = A + \bar{C}\bar{D} + CD$

$F = A$

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- Past Papers :-

Q.1) Simplify $f(x,y,z,w,u) = (x+y+z) + \overline{(x+y+z)} \cdot (w+u)$

Sol

let $R = (x+y+z)$

$F = R + \bar{R}(w+u)$

$(R+\bar{R}) \cdot (R+w+u)$

1

$x+y+z+w+u$

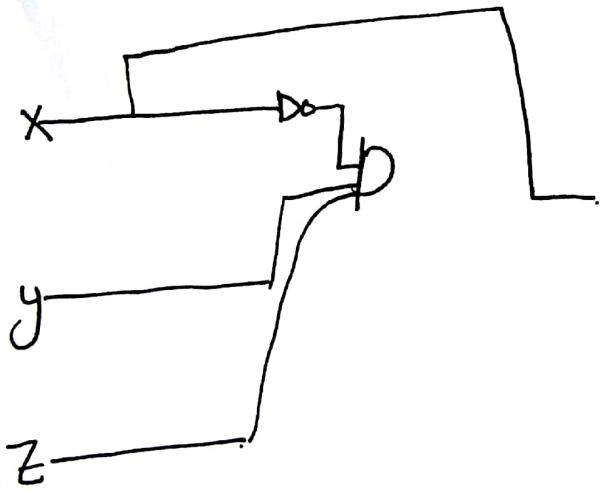
---

2) Convert $(11001111.101)_2 = (\text{CF.A})_{16}$??

C F . A

---

3) What is the output of this circuit?



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