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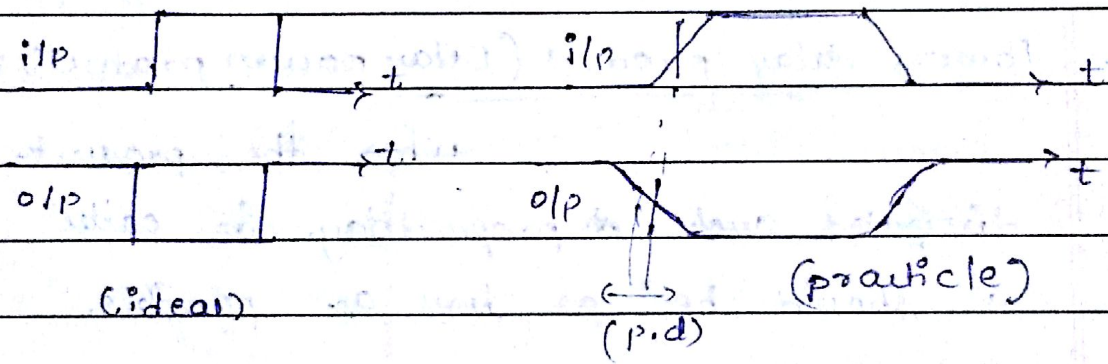
Logic Levels and Logic Families.

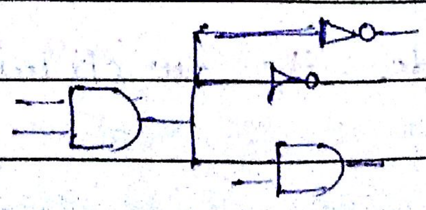
① Noise margin
② Propagation delay.
③ Fan in.
④ Fan out.
⑤ Power dessipation.
⑥ Delay power product.

② pro. delay



3) Fan-in : maximum amount of i/p for a gate is called Fan-in of a gate.

4) Fan-out : max. number of o/p for a gate is called Fan-out of a gate.



BNC - Binary Notch connector.

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1. **Noise Margin:**
To avoide the ~~wrong i/p~~ alteration produced by noise in the i/p. ~~we~~ a margin is created above and below max. and min. logic levels (vol. levels) it's known as noise margin.

2. ~~prop. delay:~~
~~The delay occured during i/p & o/p signals is known as prop. delay..~~

3. **Power. delay product (Delay power product):**
~~when~~ the product of power dissipated and ~~at~~ prop. delay is called P. d. P.
it should be as less as possible.

2. **prop. delay:** It is a parameter which gives info. about how fast o/p changes with respect to i/p.

5. **Power dissipation:**
power lost ~~durin~~ in the form ~~terms~~ of heat inside the ~~ttu~~ circuit.

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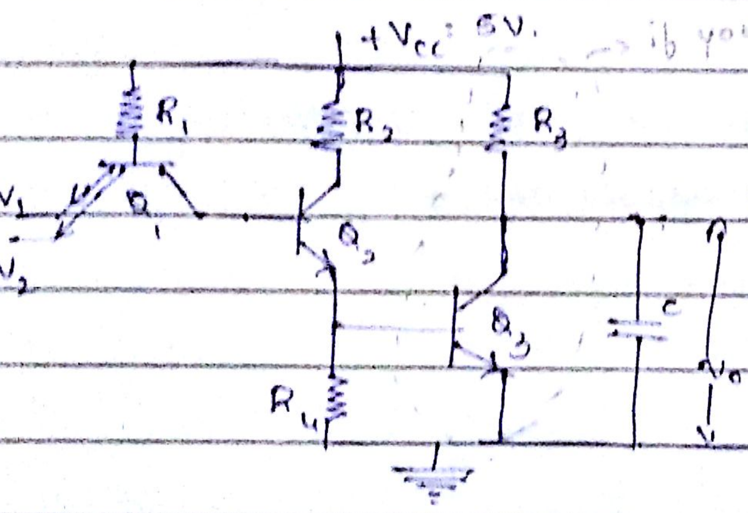
logic family.

1) ECL - Emitter coupled logic
2) TTL
3) DTL
4) RTL
5) MOS - metal oxide semiconductor
6) CMOS.
7) I^2L.

TTL - NAND.



β = Current gain = $\frac{I_C}{I_B}$

$V_0 = V_{CC} - I_C R_C$

A	B	D	P
0	0		1
0	1		1
1	0		1
1	1		0

3 npn transistors are connected with resistors for biasing as shown in fig.

functioning-

* If V_1 & V_2 are High. then. transistor Q_1 will be off. then Q_2 will get less voltage at base ~~will be less~~
* As a result Q_2 will be ON and it allowed to flow

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current through it as a result Q_3 will also be on and it will also allow current to flow throu. it. and output that we will get is zero (less voltage).

- Similar ~~Same~~ operations takes place while one of the input High and another is low transistor Q_1 will be on as a result base of Q_2 is high. and becoz of this Q_2 will be off as a result Q_3 also off and we get V_{cc} as output.

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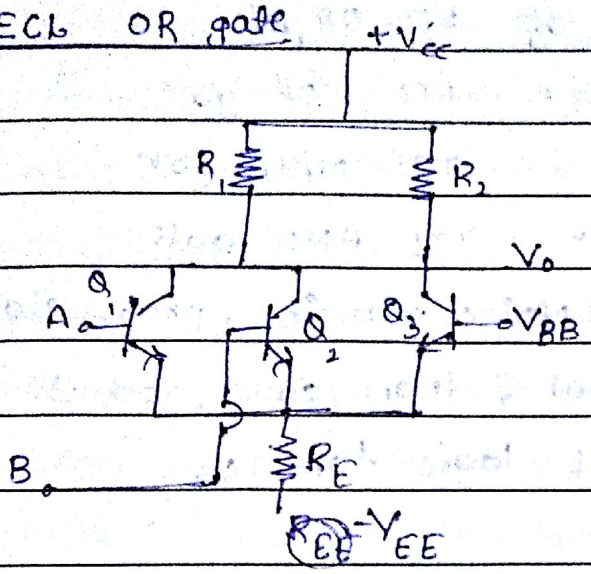
ECL OR gate



V_a	V_B	V_o'
L	L	L
L	H	H
H	L	H
H	H	H

design: 3 npn transistors are connected as shown in the fig. (3) resistors are used to make proper biasing.

working:
when V_A & V_B are low. transistor Q_1 & Q_2 both will be off as. base emmitter junction will be reverse biased.

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construction:

Multiemmitter transistor is used. To build the circuit 3 npn. transistors connected as shown in the fig. few resis-tors are used to bias them using V_{cc} (5V).

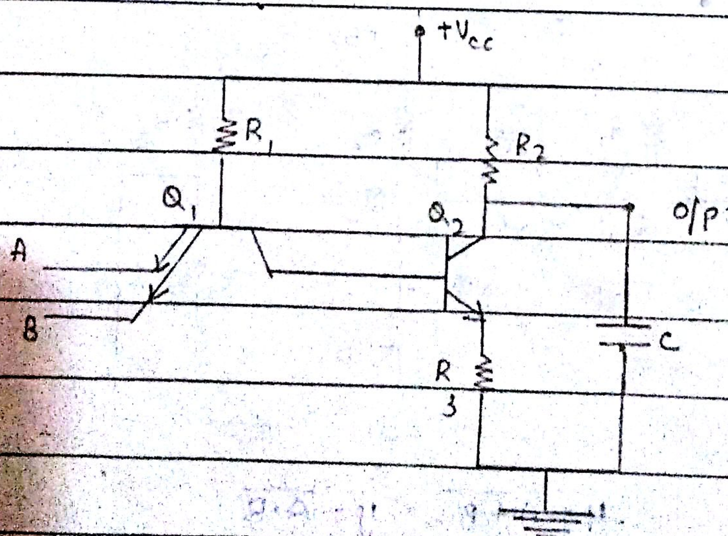
working:

case 1:

when ~~one or~~ both the i/ps are High ~~low~~. Q_1 is reverse biased, as a result base of Q_2 get low volt. and it will be on. and Q_2 will conduct. and Q_3 also will be on and it will conduct as a result o/p will be zero or low.

case 2: When one or both the inputs are low. base-collector region of Q_1 will be reverse biased and ~~Q_2 & Q_3~~ it will be ON. as a result of it Q_2 & Q_3 will become off the they will not conduct. So the o/p will be high or V_{cc}.

4) TTL AND gate.



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I/P		O/P
A	B	y
L	L	L
L	H	L
H	L	L
H	H	H

$y = A \cdot B$

construction:

multiemmitter transistors are used to build circuit 2 npn. transistors connected as shown in the fig. Few resi. are used to bias them using V_{cc} (5v).

working:

case 1: When both the i/ps are High. Q_1 is reverse biased, as a result. base of Q_2 get low voltage. And it will be cut off. as a result. output will be V_{cc}.

case 2: when one or both the inputs are Low. Q_1 is forward biased, as a result base of Q_2 get high volt. and it will start to conduct. and 5V (V_{cc}) will be drained thro. ground. as a result output will be zero or low.

5\. a) Noise margin:

To avoide the alteration produced by noise in the input.. a margin is created above and below maximum and minimum logic levels (volt. levels). This is known as noise margin.

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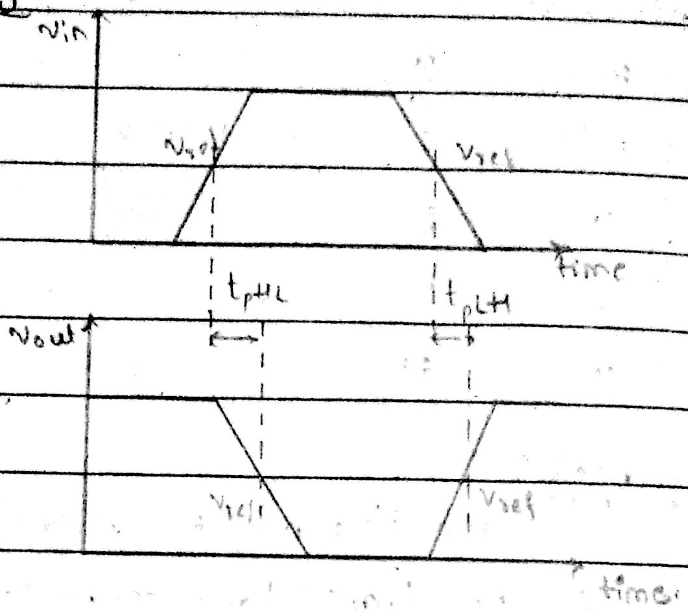
b). <u>Propagation delay:</u>



It is the parameter which gives information about how fast o/p changes with respect to input.

c). <u>Power dissipated:</u>
Power lost in the form of heat in the circuit

d) Fan-in: Maximum ~~amo~~ number of ~~heo~~ inputs to a gate is known as the fan-in of a gate.

e) <u>Fan-out</u>: Maximum number of outputs to a gate is known as the fan-out of a gate.

f). Power delay <u>product</u>: The product of the power dissipated and <u>propagation delay</u> is known as the power delay product. It should be as less as possible.

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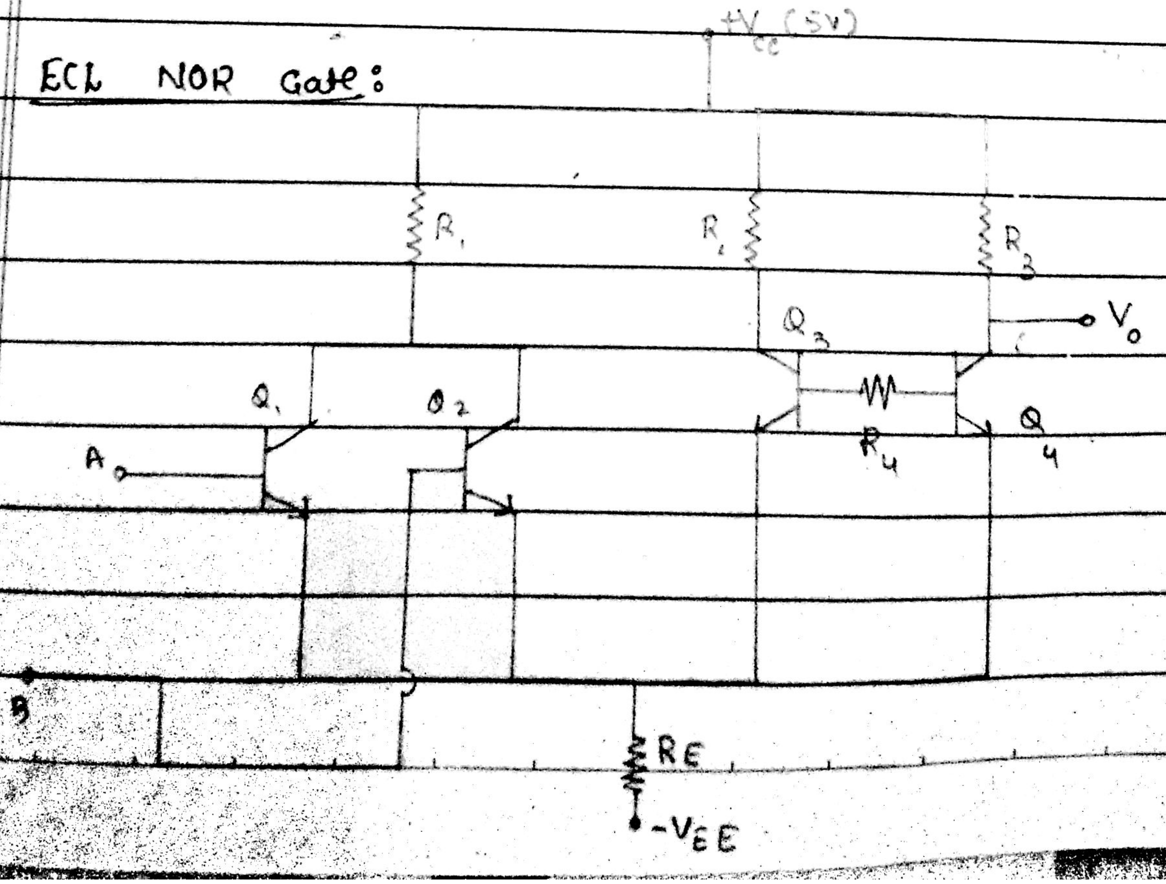
6). ~~ECL~~ ~~TTL~~.

Parameters	ECL	TTL
a. Noise margin	Good	very good.
b. prop. delay.	very less	high.
c. power dissipated	high.	relatively low.
d. Fan-in	~~min~~	
e. fan-out.	max ~~25~~, 25,	max 10.
f. Power delay product	less	relatively high.

2. ECL NOR Gate:



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i/p		o/p
A	B	Y
L	L	H
L	H	L
H	L	L
H	H	L

working :

→ when both the inputs are ~~high~~ low. both Q_1 & Q_2 are ~~cutt~~ cutoff. Here Q_3 conducts. & V_{cc} is get at V_0. (high)

→ when both the inputs are high or one of the inputs are high. then V_{cc} is drained throo. Q_1 or Q_2.

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for binary

8	4	2	1	
0	0	0	0	— 0
0	0	0	1	— 1
0	0	1	0	— 2
0	0	1	1	— 3

imp :- $A + \bar{A}B = A + B$

Combinational Logic.

$y = f(P,Q,R) = \bar{P}\bar{Q}\bar{R} + \bar{P}\bar{Q}R + \bar{P}Q\bar{R} + \bar{P}QR + PQR$

$= \bar{P}\bar{Q}(\bar{R}+R) + \bar{P}Q[\bar{R}+R] + PQR$

$= \bar{P}\bar{Q} + \bar{P}Q + PQR$

$= \bar{P}(\bar{Q}+Q) + PQR$

$= \bar{P} + (P)QR$

$= \bar{P} + QR$ //

Minterms - (+ve logic) canonical expression.

$y = f\{P,Q,R\} = \Sigma m(0,1,2,3,7)$.

Maxterms canonical expression. (-ve logic).

$y = f\{P,Q,R\} = \Pi M(4,5,6)$.

how to convert simple in complex form

$y = f(P,Q,R) = \bar{P} + QR$

$= \bar{P} + (QR)(P+\bar{P})$

$= \bar{P} + PQR + \bar{P}QR$

$= \bar{P}(Q+\bar{Q}) + PQR + PQR$

$= \bar{P}Q + \bar{P}\bar{Q} + PQR + \bar{P}Q \cdot R$

$= \bar{P}Q(R+\bar{R}) + \bar{P}\bar{Q}(R+\bar{R}) + PQR + \bar{P}QR$

$= \bar{P}QR + \bar{P}Q\bar{R} + \bar{P}\bar{Q}R + \bar{P}\bar{Q}\bar{R} + PQR + \bar{P}QR$

$= \bar{P}QR + \bar{P}Q\bar{R} + \bar{P}\bar{Q}R + \bar{P}\bar{Q}\bar{R} + PQR + \bar{P}QR$

$= \Sigma m(1,2,3,7)$ or $\Sigma m(m_0, m_1, m_2, m_3, m_7)$.

$P: x(y+z)$, $Q: x+(yz)$

$: xy+xz$ $\quad (x+y)\cdot(y+z)$

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* principle of duality. $\Rightarrow$ $\cdot \longrightarrow +$

$+ \longrightarrow \cdot$

$1 \longrightarrow 0$

$0 \longrightarrow 1$

Ex: $x+\bar{x}=1$

$x \cdot x = 0$

maxterm

$$y = f(P,Q,R) = \bar{P} + QR$$

$$= (\bar{P}+Q)(\bar{P}+R)$$

$$= (\bar{P}+Q+R\bar{R})\cdot(\bar{P}+R+Q\bar{Q})$$

$$= (\bar{P}+Q+R)(\bar{P}+Q+\bar{R})\cdot(\bar{P}+R+Q)(\bar{P}+R+\bar{Q})$$

$$y = f(P,Q,R) = \pi M(M_4, M_5, M_6)$$

Ex 2) ~~we~~ $P = f(x,y,z) = \bar{x}(\bar{y}+z)+\bar{z}$ write minterm & max. term canonical expression

minterm:

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

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

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

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

$$= \bar{x}\bar{y}z + \bar{x}\bar{y}\bar{z} + \bar{x}zy + \bar{x}\cancel{z\bar{y}} + xy\bar{z} + x\bar{y}\bar{z} + \cancel{\bar{z}\bar{x}y}\ \bar{x}y\bar{z} + \cancel{\bar{z}\bar{x}\bar{y}}\ \bar{z}\bar{y}\bar{x}$$

$$= \Sigma m(m_1, m_0, m_4, m_1, m_3, m_4, m_2, m_0, m_6)$$

implicant - 1
implicates - 0

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: $\Sigma m(m_0, m_1, m_2, m_3, m_4, m_6)$.

maxterm:

$$P: \bar{x}(\bar{y}+z)+\bar{z}$$
$$= \bar{x}(\bar{y}+z)+\bar{z}$$
$$= (\bar{x}+\bar{z})\cdot\{(\bar{y}+z)+\bar{z}\}$$
$$= (\bar{x}+\bar{z}+y\bar{y})\cdot\{(\bar{y}+z)+\bar{z}+x\bar{x}\}$$
$$= (\bar{x}+\bar{z}+y)\cdot(\bar{x}+\bar{z}+\bar{y})\cdot\{(\bar{y}+z+\bar{z}+x)\cdot(\bar{y}+z+\bar{z}+\bar{x})\}$$
$$= (\bar{x}+\bar{z}+y)\cdot(\bar{x}+\bar{z}+\bar{y})\cdot 1\cdot 1$$
$$= \Pi M(5,7).$$

Karnaugh Map reduction: (K-map).
(grouping en)

$P = f(x,y,z) = \Sigma m(0,1,3,5,6)$

x \ yz	00	01	11	10
0	1 (0)	1 (1)	1 (3)	0 (2)
1	0 (4)	1 (5)	0 (7)	1 (6)

x \ yz	00	01	11	10
0	1 (0)	1 (1)	1 (3)	0 (2)
1	0 (4)	1 (5)	1 (7)	0 (6)

3.

wx \ yz	00	01	11	10
00	0	1	0	1
01	0	0	1	0
11	1	1	0	1
10	1	1	1	0

H.W

1. Evaluate 5 minterm & maxterm problems.

H.W

1) $y = f(x,y,z) = yz + (\bar{x}+y)(x+\bar{z})$.

$= yz + x\cdot\bar{x} + x\bar{z} + yx + y\bar{z}$

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

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

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

$= \Sigma m(0,2,4,5,6,7)$

maxterms

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

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

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

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

$= (\bar{x}+y)\cdot(\bar{x}+y+z)\cdot(x+y+\bar{z})\cdot(x+1)$

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

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

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

$= \Pi M(1,4,5).$

2). $f(x,y,z) = (\overline{xy + \bar{x}z}) + yz$

$= (\overline{xy}\cdot\overline{\bar{x}z}) + yz$

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

(i) minterms: $\bar{x}\cdot x + x\bar{y} + \bar{x}\bar{z} + \bar{y}\bar{z} + yz$

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

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

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

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

$\Sigma m(0,2,3,4,5,7).$

ii) maxterm: $(\bar{x}+\bar{y})\cdot(x+\bar{z}) + yz$

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

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

$= 1\cdot(\bar{x}+\bar{y}+z)\cdot(x+y+\bar{z})\cdot 1$

$\Pi M(1,6).$

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

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

minterm: $xy\bar{x} + xz\bar{x} + \bar{x}\bar{y}z + xyz + xzz + \bar{y}zz$

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

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

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

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

$= \Sigma m(1, 3, 7)$

(ii) maxterm

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

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

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

$= \Pi M(0, 2, 3, 4, 6)$ //

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

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

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

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

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

$= \Sigma m(3, 4, 7)$

(ii) maxterms

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

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

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

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

$\Pi M(0, 1, 2, 5, 6)$ //

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

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

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

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

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

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

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

$= \Sigma m(2,4,5,6,7)$.

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

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

$= 1\cdot(x+y+z\bar{z})\cdot(x+\bar{z}+y\bar{y})$

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

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

$\cancel{\Pi(0,1,3)}$

$\Pi M(0,1,3)$ //

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

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

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

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list of (group of implicants
+ prime implicants

1) $f(w,x,y,z) = P: \Sigma m(0,2,5,11,15)$.

wx \ yz	00	01	11	10
00	1	0	0	1
01	0	1	0	0
11	0	0	1	0
10	0	0	1	0

P.I : wyz, $\bar{w}\bar{x}\bar{z}$, $\bar{w}x\bar{y}z$

MS : $wyz + \bar{w}\bar{x}\bar{z} + x\bar{y}z$

3)

1	0	0	1
0	1	1	0
0	1	1	1
1	0	0	1

P.I : $\bar{x}\bar{z}$, xz, wxy, $\bar{x}\bar{y}\bar{z}$ $wy\bar{z}$

E.P.I : $\bar{x}\bar{z}$, xz

MS1 : $\bar{x}\bar{z} + xz + wxy$

MS2 : $\bar{x}\bar{z} + xz + wy\bar{z}$

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1) $f(w,x,y,z) = \sum m(1,3,4,6,7,9,11,13,15)$.

wx \ yz	00	01	11	10
00	0	1	1	0
01	1	0	1	1
11	0	1	1	0
10	0	1	1	0

PI's : $\bar{w}xy,\ wz,\ \bar{x}z,\ \bar{w}x\bar{z},\ yz$

EPI's : $wx,\ \bar{x}z,\ \bar{w}x\bar{z}$

MS1 = $wx + \bar{x}z + \bar{w}x\bar{z} + \bar{w}xy$

MS2 = $wx + \bar{x}z + \bar{w}x\bar{z} + yz \longrightarrow$ sol^n

2) $f(w,x,y,z) = \sum m(1,3,4,5,10,11,12,14)$.

wx \ yz	00	01	11	10
00	0	1	1	0
01	1	1	0	0
11	1	0	0	1
10	0	0	1	1

MS1, ~~PI's~~ = $\cancel{\bar{w}\bar{x}y,\ wz}.\ \bar{w}\bar{x}z + \bar{w}x\bar{y}\ \cancel{+ wx\bar{z}} + wx\bar{z} + w\bar{x}y$

MS2 = $x\bar{y}\bar{z} + \bar{w}\bar{y}z + \bar{x}y\bar{z} + wy\bar{z}$

P.I - prime Implicant

E.P.I - Essential prime Implicant.

H.W   MS - minimal solution.

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4.6. Using K-maps, determine all the minimal sums and minimal products

a) $f(x,y,z) = \Sigma m(1,3,4,5,6,7)$

$x \backslash yz$	00	01	11	10	
0	0	1	1	0	$\rightarrow z$
1	1	1	1	1	$\rightarrow x$

P.I : $x + z$ x, z

E.P.I : x , z

MS : $x + z$

b). $f(x,y,z) = \Sigma m(2,3,4,5,7)$

$x \backslash yz$	00	01	11 (yz)	10	
0	0	0	1	1	$\rightarrow \bar{x}y$
1	1	1	1	0	
	$x\bar{y}$		xz		

PI - $x\bar{y}, xz, yz, \bar{x}y$

EPI - $x\bar{y}, \bar{x}y$

MS1 - $x\bar{y} + \bar{x}y + xz$

MS2 - $x\bar{y} + \bar{x}y + yz$

c) $f(x,y,z) = \Pi M(2,4,7)$.

c)

$x \backslash yz$	00	01	11	10
0	1^{0}	1^{1}	1^{3}	$\boxed{0}^{2}$ → $\bar{x}y\bar{z}$
$x\bar{y}\bar{z}$ ← 1	$\boxed{0}^{4}$	1^{5}	$\boxed{0}^{7}$ → xyz	1^{6}

~~P.I~~ -

P.I - xyz, $\bar{x}y\bar{z}$, $x\bar{y}\bar{z}$

MS - $xyz + \bar{x}y\bar{z} + x\bar{y}\bar{z}$

d) $f(x,y,z) = \Pi M(1,2,5,6,7)$.

$x \backslash yz$	00	01 → $\bar{y}z$	11	10
0	1^{0}	0^{1}	1^{3}	0^{2} → $y\bar{z}$
1	1^{4}	0^{5} → xz	0^{7}	0^{6} → xy

P.I's = $xz, xy, y\bar{z}, \bar{y}z$

EPI = $y\bar{z}, \bar{y}z$

MS1 = $y\bar{z} + \bar{y}z + xz$

MS2 = $y\bar{z} + \bar{y}z + xy$.

4.7) Solve using K-map.

a) $f(x,y,z) = \Sigma m(2,4,5,6,7)$.

$x \backslash yz$	00	01	11	10
0	0^{0}	0^{1}	0^{3}	1^{2} → $y\bar{z}$
x ← 1	1^{4}	1^{5}	1^{7}	1^{6}

P.I = $x, y\bar{z}$

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

b). $f(x,y,z) = \Sigma m(0,1,2,3,4,6,7)$

$x \backslash yz$	00	01	11	10
0	1	1	1	1
1	1	0	1	1

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

P.I : $\bar{x}$, y, $\bar{y}\bar{z}$, $x\bar{z}$

EPI : $\bar{x}$, y

MS1 : $\bar{x} + y + \bar{y}\bar{z}$

MS2 : $\bar{x} + y + x\bar{z}$

c). $f(x,y,z) = \Pi M(1,4,5,6)$

$x \backslash yz$	00	01	11	10
0	1	0	1	1
1	0	0	1	0

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

P.I : $x\bar{y}$, $x\bar{z}$, $\bar{y}z$

EPI : $x\bar{z}$, $\bar{y}z$

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

d) $f(x,y,z) = \Pi M(1,4,5)$.

$x \backslash yz$	00	01	11	10
0	1	0	1	~~0~~1
1	0	0	1	1

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

P.I : $x\bar{y}$, $\bar{y}z$

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

4.8 using K-map, solve.

a) $f(w,x,y,z) = \Sigma m(0,1,6,7,8,14,15)$

$\bar{w}\bar{x}\bar{y}$

wx \ yz	00	01	11	10
00	1	1	0	0
01	0	0	1	1
11	0	0	1∅	1∅
10	1∅	0	0	0

→ xy

→ $\bar{x}\bar{y}\bar{z}$

P.I = $\bar{w}\bar{x}\bar{y}$, $\bar{x}\bar{y}\bar{z}$, xy.

MS = $xy + \bar{w}\bar{x}\bar{y} + \bar{x}\bar{y}\bar{z}$.

b) ~~$f(x,y,$~~ $f(w,x,y,z) = \Sigma m(3,4,6,9,11,12,13,14,15)$

wx \ yz	00	01	11	10
00	0	0	1	0
01	1	0	0	1
11	1	1	1	1
10	0	1	1	0

$x\bar{y}\bar{z}$ ←

→ $xy\bar{z}$

→ wx

wz

→ wyz

P.I = $x\bar{y}\bar{z}$, wz, wyz, wx, $xy\bar{z}$.

EPI = $x\bar{y}\bar{z}$, wz, $xy\bar{z}$

MS = $wz + x\bar{y}\bar{z} + xy\bar{z} + wyz$

c.) $f(w,x,y,z) = \Sigma(1,3,4,6,7,9,11,13,15)$

$\bar{x}z$, yz

wx \ yz	00	01	11	10
00	0	1	1	0
01	1	0	1	1
11	0	1	1	0
10	0	1	1	0

$\bar{w}x\bar{z}$, $\bar{w}xy$, wz

PI's = $\bar{w}x\bar{z}$, wz, $\bar{w}xy$, yz, $\bar{x}z$

EPI = wz, $\bar{x}z$, $\bar{w}x\bar{z}$

MS = $wz + \bar{x}z + \bar{w}x\bar{z} + yz$

d). $f(x,y,z) = \pi M(1,4,5,6,14)$.

$\bar{w}\bar{y}z$

wx \ yz	00	01	11	10
00	1	0	1	1
01	0	0	1	0
11	1	1	1	0
10	1	1	1	1

$\bar{w}x\bar{y}$, $\bar{w}xy$, $xy\bar{z}$

primal implicates : $\bar{w}x\bar{y}$, $xy\bar{z}$, $\bar{w}xy$, $\bar{w}\bar{y}z$

essential p.i : $\bar{w}\bar{y}z$, $xy\bar{z}$

MS1 = $\bar{w}\bar{y}z + xy\bar{z} + \bar{w}x\bar{y}$

MS2 = $\bar{w}\bar{y}z + xy\bar{z} + \bar{w}xy$

e) $f(w,x,y,z) = \pi M(1,4,5,6,14)$

p.30

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wx \ yz	00	01	11	10
00	1	0	1	1
01	0	0	1	0
11	1	1	1	0
10	1	1	1	1

$\bar{w}\bar{y}z$, $\bar{w}x\bar{z}$, $xy\bar{z}$, $\bar{w}x\bar{y}$

PI : $\bar{w}x\bar{y}$, $\bar{w}\bar{y}z$, $\bar{w}x\bar{z}$, $xy\bar{z}$

EPI = $\bar{w}\bar{y}z$, $xy\bar{z}$

MS1 = $\bar{w}\bar{y}z + xy\bar{z} + \bar{w}x\bar{y}$

MS2 = $\bar{w}\bar{y}z + xy\bar{z} + \bar{w}x\bar{z}$

f) $f(w,x,y,z) = \Pi M(4,6,7,8,12,14)$

wx \ yz	00	01	11	10
00	1	1	1	1
01	0	1	0	0
11	0	1	1	0
10	0	1	1	1

$\bar{w}xy$, $x\bar{z}$, $w\bar{y}\bar{z}$

PI = $w\bar{y}\bar{z}$, $\bar{w}xy$, $x\bar{z}$

MS = $x\bar{z} + w\bar{y}\bar{z} + \bar{w}xy$.

g). $f(w,x,y,z) = \bar{w}\bar{x}z + xyz + w\bar{x}z + x\bar{y}\bar{z}$

$\Sigma m(1,4,5,7)$

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$wx \backslash yz$	00	01	11	10
00	0	1	0	0
01	1	1	1	0
11	0	0	0	0
10	0	0	0	0

$\bar{w}\bar{y}z$ $\quad \bar{w}xz$ $\quad \bar{w}x\bar{y}$

$PI = \bar{w}x\bar{y}, \bar{w}\bar{y}z, \bar{w}xz$

$MS = \bar{w}x\bar{y} + \bar{w}\bar{y}z + \bar{w}xz$

h. $f(w,x,y,z) = xz + x\bar{y}\bar{z} + \bar{w}\bar{x}y + wy\bar{z}$

$\Sigma m(1,3,4,6)$

$wx \backslash yz$	00	01	11	10
00	0	1	1	0
01	1	0	0	1
11	0	0	0	0
10	0	0	0	0

$\bar{w}\bar{x}z$ $\quad \bar{w}x\bar{z}$

$PI = \bar{w}\bar{x}z, \bar{w}x\bar{z}$

$MS = \bar{w}\bar{x}z + \bar{w}x\bar{z}$

i. $f(w,x,y,z) = (w+\bar{x}+\bar{z})(w+\bar{x}+\bar{y})(\bar{x}+\bar{y}+\bar{z})(\bar{w}+\bar{x}+z)(w+x+\bar{y}+\bar{z})$

$= \cancel{\Sigma\Pi M}\,(w+\bar{x}+\bar{z}+y\bar{y})(w+\bar{x}+\bar{y}+z\bar{z})(\bar{x}+\bar{y}+\bar{z}+w\bar{w})$

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

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

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

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

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

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$= \prod M(5,7,6,3,15,12,14)$

$= \prod M(3,5,6,7,12,14,15)$

$wx \backslash yz$	00	01	11	10
00	1	1	0	1
01	1	0	0	0
11	0	1	0	0
10	1	1	1	1

$\bar{w}xz$, $\bar{w}yz$, $\rightarrow xy$, $\rightarrow wxy$

PI = $xy,\ wxy,\ \bar{w}yz,\ \bar{w}xz$.

MG: $xy + wxy + \bar{w}yz + \bar{w}xz$

(j). $f(w,x,y,z) = (w+y+\bar{z})(\bar{x}+y+\bar{z})(\bar{w}+\bar{x}+y)(w+x+y+z)(w+\bar{x}+\bar{y}+\bar{z})$
$(\bar{w}+\bar{x}+\bar{y}+z)$

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

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

$= \prod M(1,5,13,12,0,7,14)$

$= \prod M(0,1,5,7,12,13,14)$.

$wx \backslash yz$	00	01	11	10
00	0	0	1	1
01	1	0	0	1
11	0	0	1	0
10	1	1	1	1

$\bar{w}\bar{x}\bar{y}$, $\bar{w}\bar{y}z$, $\rightarrow \bar{w}xz$, $\rightarrow wx\bar{z}$, $x\bar{y}\bar{z} \leftarrow$, $wx\bar{y} \leftarrow$

PI = $\bar{w}\bar{x}\bar{y},\ \bar{w}\bar{y}z,\ \bar{w}xz,\ wx\bar{z},\ wx\bar{y},\ x\bar{y}z$

EPI: $\bar{w}\bar{x}\bar{y},\ wx\bar{z},\ \bar{w}xz$

MS1: $\bar{w}\bar{x}\bar{y} + wx\bar{z} + \bar{w}x\bar{z} + wx\bar{y}$

MS2: $\bar{w}\bar{x}\bar{y} + wx\bar{z} + \bar{w}xz + x\bar{y}z$

4.9). using K-map solve the following:

a) $f(w,x,y,z) = \Sigma m(0,2,6,7,9,10,15)$.

wx \ yz	00	01	11	10
00	1 (0)	0 (1)	0 (3)	1 (2)
01	0 (4)	0 (5)	1 (7)	1 (6)
11	0 (12)	0 (13)	1 (15)	0 (14)
10	0 (8)	1 (9)	0 (11)	1 (10)

→ $\bar{w}\bar{x}\bar{z}$
→ $\bar{w}xy$
→ xyz
→ $\bar{x}y\bar{z}$
$w\bar{x}\bar{y}z$

P.I = $w\bar{x}\bar{y}z$, $\bar{x}y\bar{z}$, xyz, $\bar{w}xy$, $\bar{w}\bar{x}\bar{z}$

MS: $xyz + \bar{x}y\bar{z} + \bar{w}xy + \bar{w}\bar{x}\bar{z} + w\bar{x}\bar{y}z$

b) $f(w,x,y,z) = \Sigma m(0,1,2,4,5,6,7,8,9)$

wx \ yz	00	01	11	10
00	1 (0)	1 (1)	0 (3)	1 (2)
01	1 (4)	1 (5)	1 (7)	1 (6)
11	0 (12)	0 (13)	0 (15)	0 (14)
10	1 (8)	1 (9)	0 (11)	0 (10)

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

P.I = $w\bar{y}$, $\bar{w}x$, $\bar{w}\bar{x}\bar{z}$, $\bar{w}y\bar{z}$, $\bar{w}\bar{y}$

~~MS = w~~ EPI: $w\bar{y}$, $\bar{w}x$

MS1: $w\bar{y} + \bar{w}x + \bar{w}\bar{y} + \bar{w}\bar{y}\,\bar{w}y\bar{z}$

$MS2 = w\bar{y} + \bar{w}x + \bar{w}\bar{y} + \bar{w}\bar{x}\bar{z}$

c). $f(w,x,y,z) = \sum m(1,3,4,6,7,9,11,13,15)$

wx \ yz	00	01	11	10
00	0	1	1	0
01	1	0	1	1
11	0	1	1	0
10	0	1	1	0

$\bar{x}z$, yz, $\bar{w}x\bar{z}$, $\bar{w}xy$, wz

$PI = \bar{x}z, wz, yz, \bar{w}xy, \bar{w}x\bar{z}$

$EPI = wz, \bar{x}z, \bar{w}x\bar{z}$

$MS = wz + \bar{x}z + \bar{w}x\bar{z} + yz$ //

d) ~~f(x,y,~~ $f(w,x,y,z) = \prod M(0,2,6,8,10,12,14,15)$

wx \ yz	00	01	11	10
00	0	1	1	0
01	1∅	1∅	1	0
11	0	1	0	0
10	0	1	1	0

$\bar{w}\bar{x}\bar{z}$, $y\bar{z}$, $w\bar{z}$, $\bar{x}\bar{y}\bar{z}$, wxy

$P.I = \bar{w}\bar{x}\bar{z}, w\bar{z}, \bar{x}\bar{y}\bar{z}, wxy, y\bar{z}$

$EPI = w\bar{z}, wxy, y\bar{z}$

$MS1 = w\bar{z} + y\bar{z} + wxy + \bar{w}\bar{x}\bar{z}$

$MS2 = w\bar{z} + y\bar{z} + wxy + \bar{x}\bar{y}\bar{z}$

MS - minimal sum

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e). $f(w,x,y,z) = \Pi M(0,2,3,5,6,9,10,11,13)$

wx \ yz	00	01	11	10
00	0	1	0	0
01	1	0	1	0
11	1	0	1	1
10	1	0	0	0

$\bar w \bar x \bar z$, $\bar w y \bar z$, $x\bar y z$, $w\bar y z$, $w\bar x z$, $\bar x y$

P.I = $x\bar y z$, $w\bar y z$, $w\bar x z$, $\bar x y$, $\bar w y \bar z$, $\bar w \bar x \bar z$

E.P.I = $x\bar y z$, $\bar w \bar x \bar z$, $\bar w y \bar z$, $\bar x y$.

MS1 = $\bar x y + x\bar y z + \bar w \bar x \bar z + \bar w y \bar z + \cancel{x\bar y z}\, w\bar y z$

MS2 = $\bar x y + x\bar y z + \bar w \bar x \bar z + \bar w y \bar z + w\bar x z$

f) $f(w,x,y,z) = \Pi M(1,5,10,14)$.

wx \ yz	00	01	11	10
00	1	0	1	1
01	1	0	1	1
11	1	1	1	0
10	1	1	1	0

$\bar x \bar y z$, $w y \bar z$

P.I = $\bar x \bar y z$, $w y \bar z$

MS = $\bar x \bar y z + w y \bar z$

g) $f(w,x,y,z) = wx + \bar y z + w\bar x \bar y + \bar w x y z$

$= wx(y+\bar y) + \bar y z(x+\bar x) + w\bar x \bar y(z+\bar z) + \bar w x y z$

$= wxy + wx\bar y + x\bar y z + \bar x \bar y z + w\bar x \bar y z + w\bar x \bar y \bar z + \bar w x y z$

$= wxy(z+\bar z) + wx\bar y(z+\bar z) + x\bar y z(w+\bar w) + (\bar x \bar y z)(w+\bar w)$

$+ w\bar x \bar y z + w\bar x \bar y \bar z + \bar w x y z$

Scanned by CamScanner

$= wxyz + wxy\bar{z} + wx\bar{y}z + wxy\bar{z} + \cancel{wx\bar{y}z} + \bar{w}x\bar{y}z + w\bar{x}\bar{y}z$

$+ \bar{w}\bar{x}\bar{y}z + w\bar{x}\bar{y}z + w\bar{x}\bar{y}\bar{z} + \bar{w}xyz.$

$= \Sigma m(15, 14, 13, 5, 9, 1, 8, 7).$

$= \Sigma m(1, 5, 7, 8, 9, 13, 14, 15).$

wx \ yz	00	01	11	10
00	0 (0)	1 (1)	0 (3)	0 (2)
01	0 (4)	1 (5)	1 (7)	0 (6)
11	0 (12)	1 (13)	1 (15)	1 (14)
10	1 (8)	1 (9)	0 (11)	0 (10)

$\rightarrow wxy$

$w\bar{x}\bar{y}$ $\quad \bar{y}z$ $\quad xz$

P.I – $xz, \bar{y}z, w\bar{x}\bar{y}, wxy.$

MS – $xz + \bar{y}z + w\bar{x}\bar{y} + wxy.$

h). $f(w,x,y,z) = xy + y\bar{z} + \bar{x}\bar{y}\bar{z} + x\bar{y}z + wx\bar{y} + w\bar{y}z$

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

$+ wx\bar{y}(z+\bar{z}) + w\bar{y}z(x+\bar{x}).$

$= wxy + \bar{w}xy + xy\bar{z} + \bar{x}y\bar{z} + w\bar{x}\bar{y}\bar{z} + \bar{w}\bar{x}\bar{y}\bar{z} + wx\bar{y}z$

$+ \bar{w}x\bar{y}z + wx\bar{y}z + wx\bar{y}\bar{z} + wx\bar{y}z + w\bar{x}\bar{y}z.$

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

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

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

$= wxyz + wxy\bar{z} + \bar{w}xyz + \bar{w}xy\bar{z} + wxy\bar{z} + \bar{w}xy\bar{z} + w\bar{x}y\bar{z} +$

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

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

$= \Sigma m(15, 14, 7, 6, 10, 2, 8, 0, 13, 5, 12, 9)$

$= \Sigma m(0,2,5,6,7,8,9,10,12,13,14,15)$

wx \ yz	00	01	11	10
00	1 (0)	0 (1)	0 (3)	1 (2)
01	0 (4)	1 (5)	1 (7)	1 (6)
11	1 (12)	1 (13)	1 (15)	1 (14)
10	1 (8)	1 (9)	1 (11)	1 (10)

$\to \bar{w}y\bar{z}$, $\to xy$, $\to w$, $\to \bar{x}\bar{z}$, xz

$PI = \bar{x}\bar{z}, w, xy, \bar{w}y\bar{z}, xz$

$EPI = \bar{x}\bar{z}, w, xz,$

$MS = w + \bar{x}\bar{z} + xz + xy$ //

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

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

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

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

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

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

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

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

$= \Pi M(4,5,6,7,0,12,15,2)$

$= \Pi M(0,2,4,5,6,7,12,15)$

wx \ yz	00	01	11	10
00	0 (0)	1 (1)	1 (3)	0 (2)
01	0 (4)	0 (5)	0 (7)	0 (6)
11	0 (12)	1 (13)	0 (15)	1 (14)
10	1 (8)	1 (9)	1 (11)	1 (10)

$\to \bar{w}\bar{z}$, $\to \bar{w}x$, $x\bar{y}\bar{z}$, xyz

PI : $\bar{w}x,\ \bar{w}\bar{z},\ x\bar{y}\bar{z},\ xyz$

MS : $\bar{w}x + \bar{w}\bar{z} + x\bar{y}\bar{z} + xyz$

(j) ~~w~~ $f(w,x,y,z) = (w+\bar{y}+\bar{z})(\bar{w}+x+\bar{y})(w+x+\bar{y}+z)(\bar{w}+\bar{x}+y+z)$

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

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

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

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

$= \Pi M(2, 6, 10, 11, 12)$

wx \ yz	00	01	11	10
00	1 (0)	1 (1)	1 (3)	0 (2)
01	1 (4)	1 (5)	1 (7)	0 (6)
11	0 (12)	1 (13)	1 (15)	1 (14)
10	1 (8)	1 (9)	0 (11)	0 (10)

$\bar{w}y\bar{z}$

$wx\bar{y}\bar{z}$

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

$w\bar{x}y$

P.I = $\bar{w}y\bar{z},\ \bar{x}y\bar{z},\ w\bar{x}y,\ wx\bar{y}\bar{z}$

EPI = $wx\bar{y}\bar{z},\ w\bar{x}y,\ \bar{w}y\bar{z}$

MS = $wx\bar{y}\bar{z} + w\bar{x}y + \bar{w}y\bar{z}$

x	y	z	p
0	0	0	x
0	0	1	1
0	1	0	1
0	1	1	x

x ⟶ (don't care) (dC) = don't care

Problems

4.10

1) $f(w,x,y,z) = \Sigma m(1,2,10,12,14,15) + dc(9,11,13)$

wx \ yz	00	01	11	10
00	0	1	0	1
01	0	0	0	0
11	1	X	1	1
10	0	X	X	1

P.I's: wx, wz, wy, ~~$wy\bar{z}$~~ $\bar{x}\bar{y}z$, $\bar{x}y\bar{z}$

EPI's are,: $\bar{x}\bar{y}z$, $\bar{x}y\bar{z}$, wx

$MSO = \bar{x}y\bar{z} + \bar{x}y\bar{z} + wx$ //

2) $f(w,x,y,z) = \Sigma m(2,5,6,7,8,9,13,15) + dc(0,4,10,11,12)$

wx \ yz	00	01	11	10
00	X	0	0	1
01	X	1	1	1
11	X	1	1	0
10	1	1	X	X

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$P_1 = \bar{y}\bar{z}, \bar{x}\bar{z}, w\bar{x}, \bar{w}x, w\bar{y}, wz, xz, x\bar{y}, \bar{w}\bar{z}$

$MS_1 = xz + w\bar{x} + \bar{w}\bar{z}$

$MS_2 = \bar{w}x + wz + \bar{x}\bar{z}$

3) $f(w,x,y,z) = \Pi M(2,5,6,7,8,9,13,15)$

minimal product.

wx \ yz	00	01	11	10
00	1	1	1	0
01	1	0	0	0
11	1	0	0	1
10	0	0	1	1

prime implicates: $(\bar{x}+\bar{z}), (\bar{w}+x+\bar{y}), (w+\bar{y}+z), (\bar{w}+y+\bar{z})$

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

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

MP (minimal products) $= (\bar{x}+\bar{z})\cdot(\bar{w}+x+y)(w+\bar{y}+z)$ //

4) $f(x,y,z) = \Sigma m(1,2,4,5) + dc(6)$ MP?

$\Pi M(0,3,7) + dc(6)$

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4.11. K-map

a. $f(w,x,y,z) = \Sigma m(0,1,2,5,8,15) + dc(6,7,10)$

wx \ yz	00	01	11	10
00	1 (0)	1 (1)	0 (3)	1 (2)
01	0 (4)	1 (5)	X (7)	X (6)
11	0 (12)	0 (13)	1 (15)	0 (14)
10	1 (8)	0 (9)	(11)	X (10)

$\bar{w}\bar{y}z$, $\bar{w}\bar{x}\bar{z}$, $\bar{w}y\bar{z}$, xyz, $w\bar{x}\bar{z}$, $\bar{x}y\bar{z}$, $\bar{x}\bar{z}$, $\bar{x}\bar{y}\bar{z}$

PI = $\bar{x}\bar{y}\bar{z}$, $\bar{x}y\bar{z}$, $w\bar{x}\bar{z}$, xyz, $\bar{w}y\bar{z}$, $\bar{w}\bar{x}\bar{z}$, $\bar{w}\bar{y}z$, $\bar{x}\bar{z}$

EPI = xyz

~~MS1 = $xyz + \bar{x}\bar{y}\bar{z} + \bar{w}\bar{y}z + \bar{w}\bar{x}\bar{z}$~~ MS = $xyz + \bar{x}\bar{z} + \bar{w}\bar{y}z$

~~MS2 = $xyz + \bar{x}\bar{y}\bar{z} + \bar{w}\bar{y}z + \bar{w}y\bar{z}$~~

~~MS3 = $xyz + \bar{x}\bar{y}\bar{z} + \bar{w}\bar{y}z + \bar{x}y\bar{z}$~~

b). $f(w,x,y,z) = \Sigma m(2,8,9,10,12,13) + dc(7,11)$

wx \ yz	00	01	11	10
00	0 (0)	0 (1)	0 (3)	1 (2)
01	0 (4)	0 (5)	X (7)	0 (6)
11	1 (12)	1 (13)	0 (15)	0 (14)
10	1 (8)	1 (9)	X (11)	1 (10)

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

PI : $w\bar{y}$; $\bar{x}y\bar{z}$, $w\bar{x}$

EPI = $w\bar{y}$, $\bar{x}y\bar{z}$

MS = $w\bar{y} + \bar{x}y\bar{z}$ //

c. $f(w,x,y,z) = \Sigma m(1,7,9,10,12,13,14,15) + dc(4,5,8)$

wx \ yz	00	01	11	10
00	0_0	1_1	0_3	0_2
01	X_4	X_5	1_7	0_6
11	1_{12}	1_{13}	1_{15}	1_{14}
10	X_8	1_9	0_{11}	1_{10}

$x\bar{y}$ ← 01 → xz
11 → wx
$w\bar{z}$
$w\bar{y}$ $\bar{y}z$

$PI = x\bar{y}, w\bar{z}, w\bar{y}, \bar{y}z, wx, xz$

$EPI = \bar{y}z, xz$

$MS = xz + \bar{y}z + wx$

d. $f(w,x,y,z) = \Sigma m(7,9,11,12,13,14) + dc(3,5,6,15)$

wx \ yz	00	01	11	10
00	0_0	0_1	X_3	0_2
01	0_4	X_5	1_7	X_6
11	1_{12}	1_{13}	X_{15}	1_{14}
10	0_8	1_9	1_{11}	0_{10}

xz ← → xy
→ wx
wz yz

$P.I = xz, wz, yz, wx, xy$

$EPI = wx, wz$

$MS1 = wx + wz + xy$

$MS2 = wx + wz + xz$

$MS3 = wx + wz + yz$

e). $f(w,x,y,z) = \Sigma m(0,2,6,8,10) + dc(1,4,7,11,13,14)$

wx \ yz	00	01	11	10
00	1 [0]	X [1]	0 [3]	1 [2]
01	X [4]	0 [5]	X [7]	1 [6]
11	0 [12]	X [13]	0 [15]	X [14]
10	1 [8]	0 [9]	X [11]	1 [10]

$\overline{w}\overline{x}\overline{y}$, $\overline{w}\overline{z}$, $\overline{w}xy$, $xy\overline{w}$, $wy\overline{z}$, $y\overline{z}$, $\overline{x}\overline{z}$, $w\overline{x}y$

PI's = $\overline{x}\overline{z}$, $w\overline{x}y$, $wy\overline{z}$, $xy\overline{w}$, $\overline{w}xy$, $\overline{w}\overline{z}$, $\overline{w}\overline{x}\overline{y}$, $y\overline{z}$

EPI = $\overline{x}\overline{z}$

MS = $\overline{x}\overline{z} + y\overline{z}$

f) $f(w,x,y,z) = \Sigma m(1,4,6,8,9,10,11,12,13) + dc(3,15)$

wx \ yz	00	01	11	10
00	0 [0]	1 [1]	X [3]	0 [2]
01	1 [4]	0 [5]	0 [7]	1 [6]
11	1 [12]	1 [13]	X [15]	0 [14]
10	1 [8]	1 [9]	1 [11]	1 [10]

$\overline{x}z$, $x\overline{y}\overline{z}$, $\overline{w}x\overline{z}$, wz, $w\overline{y}$, $w\overline{x}$

PI = $x\overline{y}\overline{z}$, $w\overline{y}$, $w\overline{x}$, wz, $\overline{w}x\overline{z}$, $\overline{x}z$

EPI: $w\overline{x}$, $\overline{w}x\overline{z}$, $\overline{x}z$

MS = $w\overline{x} + \overline{x}z + \overline{w}x\overline{z} + w\overline{y}$

h. $f(w,x,y,z) = \cancel{\Pi M(0,8} \; \Pi M(0,8,10,11,14) + dc(6)$

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

wx \ yz	00	01	11	10
00	0	1	1	1
01	0	1	1	X
11	1∅	⊗1	1	0
10	0	⊗1	0	0

$\bar{w}x\bar{z}$ $xy\bar{z}$ $wy\bar{z}$ $w\bar{x}\bar{z}$

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

PI = ~~$\bar{x}\bar{w}\bar{z}$, $w\bar{x}y$, $w\bar{x}\bar{z}$, $wy\bar{z}$, $xy\bar{z}$, $\bar{w}x\bar{z}$, $\bar{w}\bar{y}\bar{z}$~~

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

$w+y+z$

EPI = $\bar{w}+x+\bar{y}$

MP = $(\bar{w}+x+\bar{y})(\bar{w}+\bar{y}+z)(w+y+z)(\bar{w}+x+z)$.

30/08/17 Quine Mclusky.

* It can be coded (programmed)

1. ~~$f(w,x,y,z) = \Sigma m(0,2,$~~

list all the possible PI's using QM method

1) $f(w,x,y,z) = \Sigma m(0,2,3,5,6,9,10,11,13)$

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step1 step2

0 - 0000 G_1 0000(0) G_1 - 00_0 (0,2) - A

2 - 0010 G_2 - 0010 (2)

3 - 0011 0011 (3) G_2 001- (2,3)

5 - 0101 G_3 0101 (5) 0-10 (2,6) - B

6 - 0110 0110 (6) -010 (2,10)

9 - 1001 1001 (9) G_3 - -011 (3,11)

10 - ~~10~~ 1010 1010 (10) -101 (5,13) - C

11 - ~~10~~ 1011 G_4 1011 (11) 10-1 (9,11) - D

13 - 1101 1101 (13) 1-01 (9,13) - E

101- (10,11)

Step-3

w x y z

G_1 -01- (2,3,10,11) - F

-01- (2,10,3,11)

A = $\bar{w}\bar{x}\bar{z}$

B - $\bar{w}y\bar{z}$

C - $x\bar{y}z$

D - $w\bar{x}z$

E - $w\bar{y}z$

F - $\bar{x}y$

difference betn 2 nos. should be a power of '2' only then possible

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Identify all the possible prime implicates using MQ method

1) $f(w,x,y,z) = \Sigma m(0,2,3,5,6,9,10,11,13)$

$= \Pi M(1,4,7,8,12,14,15)$

		Step 1		Step 2
1 - 0001	G_1	0001(1)		
4 - 0100		0100(4)		
7 - 0111		1000(8)		
8 - 1000	G_2	1100(12)		
12 - 1100	G_3	0111(7)		
14 - 1110		1110(14)		
15 - 1111		1111(15)		

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1 0 0   1 0 0

7483 - parallel adder (4-bit)

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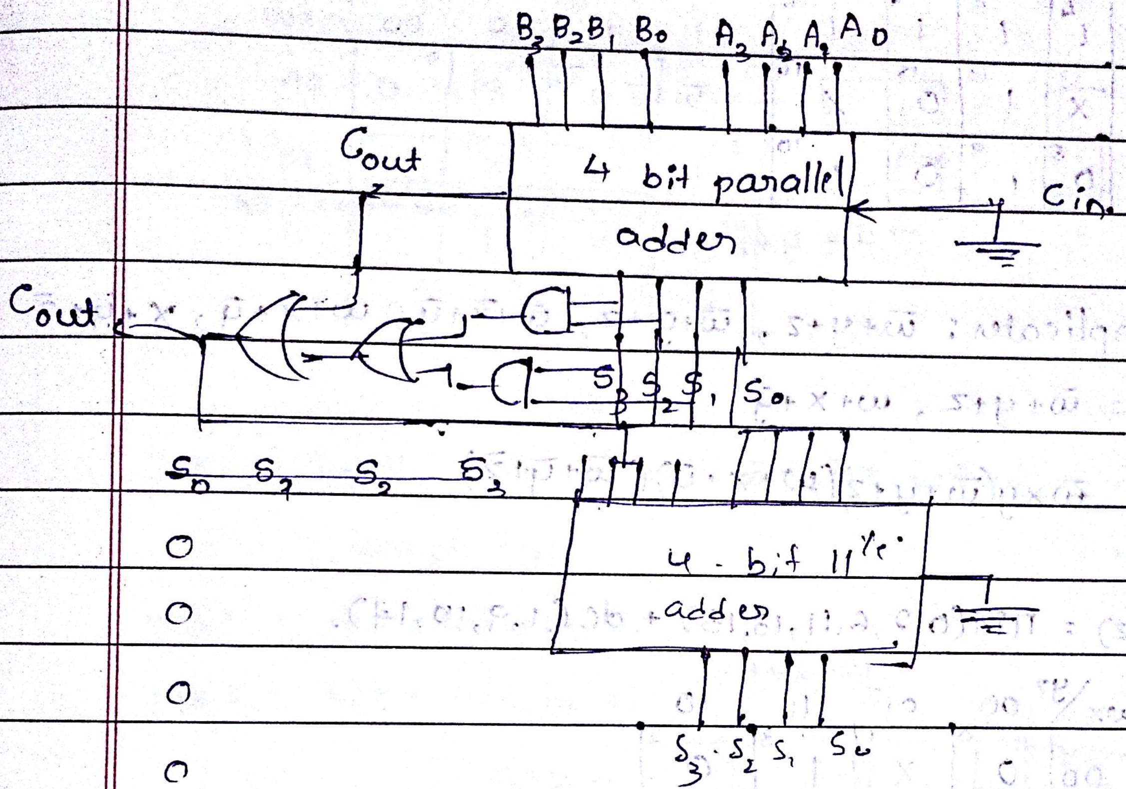
Exp. 02 - BCD adder

10m

4. bit parallel adder. (2-AND, 2-OR, 2-11 add)



S_0 S_1 S_2 S_3

0

0

0

0

0

0

1

1

4.11. i) $f(w,x,y,z) = \pi M(2,8,11,15) + dc(3,12,14)$

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

wx \ yz	00	01	11	10
00	1	1	X	0
01	1	1	1	1
11	X	1	0	X
10	0	1	0	1

prime implicates: $\bar{w}+y+z$, $\bar{w}+\bar{y}+\bar{z}$, $\bar{w}+\bar{x}+\bar{y}$, $w+x+\bar{y}$, $x+\bar{y}+\bar{z}$

E.P.Is $= \bar{w}+y+z$, $w+x+\bar{y}$

M.P $= \cancel{\bar{w}xy}(\bar{w}+y+z)(w+x+\bar{y})(\bar{w}+\bar{y}+\bar{z})$

j) $f(w,x,y,z) = \pi M(0,2,6,11,13,15) + dc(1,9,10,14)$.

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

wx \ yz	00	01	11	10
00	0	X	1	0
01	1	1	1	0
11	1	0	0	X
10	1	X	0	X

P.Is :- $w+x+z$, $\bar{w}+\bar{z}$, $\bar{w}+\bar{y}$, $\bar{y}+z$, $w+x+y$

EPI :- $\bar{w}+\bar{z}$, $\bar{y}+z$

M.P1 $= \cancel{(\bar{w}+\bar{z})(\bar{y}+z)(\bar{y}+z\,wx}\ (\bar{w}+\bar{z})(\bar{y}+z)(w+x+z)$ //

MP2 $= (\bar{w}+\bar{z})(\bar{y}+z)(w+x+y)$ //

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4.12) using K-map, determine minimal sums & products.

a). $f(w,x,y,z) = \Sigma m(6,7,9,10,13) + dc(1,4,5,11,15)$

wx \ yz	00	01	11	10
00	0	X	0	0
01	X	X	1	1
11	0	1	X	0
10	0	1	X	1

$\bar{y}z$, xz, $\bar{w}x$, $w\bar{x}y$, wz

Prime implicants: $xz, wz, \bar{w}x, \bar{y}z, w\bar{x}y$.

EPIs = $\bar{w}x, w\bar{x}y$.

MS1 = $\bar{w}x + w\bar{x}y + wz$

MS2 = $\bar{w}x + w\bar{x}y + \bar{y}z$

b) $f(w,x,y,z) =$ ~~Σm(1,5,8,1~~ $\Sigma m(1,5,8,14) + dc(4,6,9,11,15)$

wx \ yz	00	01	11	10
00	0	1	0	0
01	X	1	0	X
11	0	0	X	1
10	1	X	X	0

$\bar{w}\bar{y}z$, $\bar{w}x\bar{y}$, $xy\bar{z}$, wxy, $w\bar{x}\bar{y}$, $\bar{x}\bar{y}z$

PI = $\bar{w}x\bar{y}, w\bar{x}\bar{y}, \bar{x}\bar{y}z, wxy, xy\bar{z}, \bar{w}\bar{y}z$

EPI = $w\bar{x}\bar{y}$

MS1 = $w\bar{x}\bar{y} + \bar{w}\bar{y}z + xy\bar{z}$

MS2 = $w\bar{x}\bar{y} + \bar{w}\bar{y}z + wxy$

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c. $f(w,x,y,z) = \Sigma m(0,2,4,5,8,13,15) + dc(1,10,14)$

wx \ yz	00	01	11	10
00	1	X	0	1
01	1	1	0	0
11	0	1	1	X
10	1	0	0	X

$\bar{w}\bar{y}$, $\bar{w}\bar{x}\bar{z}$, $x\bar{y}z$, wxy, $w\bar{x}\bar{z}$, wxz, $\bar{x}y\bar{z}$

PI = $x\bar{y}z,\ w\bar{x}\bar{z},\ wxz,\ \bar{x}y\bar{z},\ wxy,\ \bar{w}\bar{x}\bar{z},\ \bar{w}\bar{y}$

EPI = $\bar{w}\bar{y},\ w\bar{x}\bar{z}$

MS1 = $\bar{w}\bar{y} + w\bar{x}\bar{z} + x\bar{y}z + \bar{w}\bar{x}\bar{z}$

MS2 = $\bar{w}\bar{y} + w\bar{x}\bar{z} + x\bar{y}z + \bar{x}y\bar{z}$

d). $f(w,x,y,z) = \Sigma m(1,3,4,6,12) + dc(0,9,13)$

wx \ yz	00	01	11	10
00	X	1	1	0
01	1	0	0	1
11	1	X	0	0
10	0	X	0	0

$\bar{x}\bar{y}z$, $\bar{w}\bar{x}z$, $\bar{w}x\bar{z}$, $x\bar{y}\bar{z}$, $wx\bar{y}$

PIs = $\bar{x}\bar{y}z,\ x\bar{y}\bar{z},\ wx\bar{y},\ \bar{w}\bar{x}z,\ \bar{w}x\bar{z}$

EPI: $\bar{w}\bar{x}z,\ \bar{w}x\bar{z}$

MS1: $\bar{w}\bar{x}z + \bar{w}x\bar{z} + x\bar{y}\bar{z}$

MS2: $\bar{w}\bar{x}z + \bar{w}x\bar{z} + wx\bar{y}$

e) $f(w,x,y,z) = \Sigma m(0,1,2,3,4,9,13) + dc(5,10,11,14)$

wx \ yz	00	01	11	10
00	1 (0)	1 (1)	1 (3)	1 (2)
01	* 1 (4)	X (5)	0 (7)	0 (6)
11	0 (12)	1 (13) *	0 (15)	X (14)
10	0 (8)	1 (9)	X (11)	X (10)

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

P.I = $\bar{w}\bar{x}, \bar{w}\bar{y}, w\bar{x}z, \bar{x}y, \bar{y}z$

EPI = $\bar{w}\bar{y}, \bar{y}z$

MS1 = $\bar{w}\bar{y} + \bar{y}z + \bar{w}\bar{x}$

MS2 = $\bar{w}\bar{y} + \bar{y}z + \bar{x}y$

f). $f(w,x,y,z) = \Sigma m(1,2,3,4,6,9,12,14) + dc(5,7,15)$

wx \ yz	00	01	11	10
00	0 (0)	1 (1)	1 (3)	1 (2) *
01	1 (4)	X (5)	X (7)	1 (6)
11	1 (12) *	0 (13)	X (15)	1 (14)
10	0 (8)	1 (9) *	0 (11)	0 (10)

$\bar{w}z$, $\bar{w}y$, $\bar{w}x$, xy, $x\bar{z}$, $\bar{x}\bar{y}z$

PI: $x\bar{z}, \bar{x}\bar{y}z, xy, \bar{w}x, \bar{w}y, \bar{w}z$

EPI = $x\bar{z}, \bar{x}\bar{y}z, \bar{w}y$

MS1 = $x\bar{z} + \bar{w}y + \bar{x}\bar{y}z$

h. $f(w,x,y,z) = \Pi M(1,4,9,11,13) + dc(0,14,15)$

wx \ yz	00	01	11	10
00	X	0	1	1
01	0	1	1	1
11	1	0	X	X
10	1	0	0	1

$w+x+y$

$w+y+z$

$x+y+\bar{z}$

$\bar{w}+\bar{z}$

P.I $= (w+y+z), (x+y+\bar{z}), (\bar{w}+\bar{z}), (w+x+y)$

EPI $= (\bar{w}+\bar{z}), (w+y+z)$

MP1 $= (\bar{w}+\bar{z})(w+y+z)(w+x+y)$

MP2 $= (\bar{w}+\bar{z})(w+y+z)(x+y+\bar{z})$

i) $f(w,x,y,z) = \Pi M(1,2,3,4,9,10) + dc(0,14,15)$

wx \ yz	00	01	11	10
00	X	0	0	0
01	0	1	1	1
11	1	1	X	X
10	1	0	1	0

$(w+x)$

$(w+y+z)$

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

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

P.I $= (w+y+z), (x+y+\bar{z}), (x+\bar{y}+z), (w+x)$

EPI $= (w+y+z), (x+y+\bar{z}), (x+\bar{y}+z), (w+x)$

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

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j). $f(w,x,y,z) = \prod M(0,3,4,11,13) + dc(2,6,8,9,10)$

wx \ yz	00	01	11	10
00	0	1	0	X
01	0	1	1	X
11	1	0	1	1
10	X	X	0	X

$(x+y+z)$

$(w+z)$

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

$(\bar{w}+x)$

$(x+\bar{y})$

P.I : $\cancel{(w+x+z)}$, $(x+y+z)$, $\cancel{(x+\bar{y}+\bar{z})}$, $(\bar{w}+x)$, $\cancel{(w+\bar{x}+z)}$, $\cancel{(w+}$

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

EPI = $(\bar{w}+y+\bar{z})$, $(w+z)$, $(x+\bar{y})$

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

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Table reduction / Row column reduction

1) Obtain minimal sum using Table reduction ~~tegnic~~ technique for follo. expression.

Soln: $p = f(w, x, y, z) = \Sigma m(3, 4, 5, 7, 10, 12, 14, 15) + dc(2)$

Q.M methode

2 - 0010	G_1 0010 (2) ✓	wxyz 001_ (2,3) - A
3 - 0011	0100 (4) ✓	_010 (2,10) - B
4 - 0100	G_2 0011 (3) ✓	010_ (4,5) - C
5 - 0101	0101 (5) ✓	_100 (4,12) - D
~~6 - 0110~~	1010 (10) ✓	0_11 (3,7) - E
7 - 0111	1100 (12) ✓	01_1 (5,7) - F
~~8 - 1000~~	G_3 0111 (7) ✓	1_10 (10,14) - G
~~9 - 1001~~	1110 (14) ✓	11_0 (12,14) - H
10 - 1010	G_4 1111 (15)	_111 (7,15) - I
12 - 1100		111_ (14,15) - J
14 - 1110		
15 - 1111		

$A : (\bar{w}\bar{x}y)$ $\quad I = (xyz)$

$B : (\bar{x}y\bar{z})$ $\quad J = (wxy)$

$C (\bar{w}x\bar{y})$

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

$E (\bar{w}yz)$

$F (\bar{w}xz)$

$G (wy\bar{z})$

$H (wx\bar{z})$

Note : ~~cos~~ if cost is less. then don't remove. exclude. don't cares.

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PI Table

	m_2	m_4	m_8	m_7	m_{10}	m_{12}	m_{14}	m_{15}	cost.
~~A~~	x								4
~~B~~					x				4
C		x	x						4
D		x				x			4
** E	x			x					4
F			x	x					4
** G					x		x		4
H						x	x		4
I				x				x	4
J							x	x	4

To identify essential PIs search for a column wi[th] single cross (x) in PI table.

Step 2: Row dominance:

=> E dominates A. So remove dominated row. (A)

=> G dominates B. " " " (B)

Step 3 Step 1: Column with single cross.

Reduced PI table.

	m_4	m_5	m_{12}	m_{15}	cost
** C	x	x			4
** D	x		x		4
~~F~~		~~x~~			~~4~~
~~H~~			~~x~~		~~4~~
I				x	4
J				x	4

C dominates F → remove F

D dominates H → remove H.

n	m15	cost
I	x	4
J	x	4

MS1 = E + G + C + D + I

MS2 = E + G + C + D + J

H.W

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8) Find minimal sum using table reduction technique

$f(w,x,y,z) = \Sigma m(1,3,6,8,9,10,12,14) + dc(7,13)$.

0001 (1)
0011 (3)
0110 (6)
~~0101~~ 0111 (7)
~~000000~~
1000 (8)
~~10010110~~
1001 (9)
~~1001010~~ (10)
1100 (12)
1101 (13)
1110 (14)

G_1
0001 (1) ✓
1000 (8) ✓

G_2
0011 (3) ✓
0110 (6) ✓
1001 (9) ✓
~~0101~~
1010 (10) ✓
1100 (12) ✓

G_3
0111 (7) ✓
1101 (13) ✓
1110 (14) ✓

100- (8,9) ✓
00-1 (1,3) E
-001 (1,9) D
10-0 (8,10) ✓
1-00 (8,12) ✓
0-11 (3,7) F
1-01 (9,13) ✓
1-10 (10,14) ✓
110- (12,13) ✓
11-0 (12,14) ✓
-110 (6,14) F
011- (6,7) G.

wxyz
1-0- (8,9,12,13) (A)
1--0 (8,10,12,14) (B)
1-0- (8,12,9,13) (A)
1--0 (8,12,10,14) (B)

~~0001 (1)~~
0
(3)
(6)
(8)
(9)
(10)

wx \ yz	00	01	11	10
00	0 (0)	1 (1)	1 (3)	0 (2)
01	0 (4)	0 (5)	X (7)	1 (6)
11	1 (12)	1 (13)	0 (15)	1 (14)
10	1 (8)	1 (9)	0 (11)	1 (10)

$w\bar{z}$

Refer PI table at end of the chap.

Exams

I) ~~A~~ Identify the minterm & maxterm canonical exp for the follo.

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

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

II) Using K-map Identify the m.s & m.p for.

1. $f(w,x,y,z) = \Sigma m(2,3,6,8,13,14,15) + dc(4,5,12)$

2. $f(w,x,y,z) = \Pi M(1,4,9,11,13) + dc(0,14,15)$

III Identify all possible P.I's using Q.M methode for

1) $f(w,x,y,z) = \Pi M(\cancel{7},9,12,13,14,15) + dc(4,11)$.

Sol^ns

I.

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

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

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

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

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

$= \cancel{\Sigma m(3,4,0}, \Sigma m(3,2,0,6,4,2,0)$

$= \Sigma m(0,2,3,4,6)$

$= \cancel{\Sigma m(0,1,2}, \Sigma m(0,1,2,\cancel{3},4,6)$

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~~chap. 03 : Analysis and design of combinational logic~~

~~carry look ahead adder.~~

(b) $f(x,y,z) = \cancel{\bar{x}\bar{z} + (\bar{y}+\bar{z})\bar{z}}\ (\bar{x}+\bar{z})(\bar{y}+\bar{z}+\bar{z})$.

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

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

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

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

$= \Pi M(3,5,7)$ //

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

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

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

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

$= \Sigma m(3,4,7)$

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

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

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

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

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

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

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

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

$= \Pi M(0,2)$ //

$f(w,x,y,z) = \sum m(2,3,6,8,13,14,15) + dc(4,5,12)$

$= \Pi M(0,1,7,9,10,11) + dc(4,5,12)$

minterm.

wx \ yz	00	01	11	10
00	0 (0)	0 (1)	1 (3)	1 (2)
01	X (4)	X (5)	0 (7)	1 (6)
11	X (12)	1 (13)	1 (15)	1 (14)
10	1 (8)	0 (9)	0 (11)	0 (10)

$x\bar{y}$, $\bar{w}\bar{x}y$, $\bar{w}y\bar{z}$, $x\bar{z}$, wx, $w\bar{y}\bar{z}$

P.I $= \bar{w}\bar{x}y,\ w\bar{y}\bar{z},\ wx,\ x\bar{z},\ \bar{w}y\bar{z},\ x\bar{y}$

EPI $= \bar{w}\bar{x}y,\ w\bar{y}\bar{z},\ wx$

MS $= wx + w\bar{y}\bar{z} + \bar{w}\bar{x}y + x\bar{z}$ //

maxterm:

wx \ yz	00	01	11	10
00	0 (0)	0 (1)	1 (3)	1 (2)
01	X (4)	X (5)	0 (7)	1 (6)
11	X (12)	1 (13)	1 (15)	1 (14)
10	1 (8)	0 (9)	0 (11)	0 (10)

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

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PI: $(w+y)$, $(w+\bar{x}+\bar{z})$, $(\bar{w}+x+\bar{y})$, $(\bar{w}+x+\bar{z})$, $(x+y+\bar{z})$

EPI = $(w+y)$, $(\bar{w}+x+\bar{y})$, $(w+\bar{x}+\bar{z})$

MP1 = $(w+y)(\bar{w}+x+\bar{y})(w+\bar{x}+\bar{z})(x+y+\bar{z})$

MP2 = $(w+y)(\bar{w}+x+\bar{y})(w+\bar{x}+\bar{z})(\bar{w}+x+\bar{z})$

2) $\Pi M(7,9,12,13,14,15) + dc(4,11)$

$\Sigma m(0,1,2,3,5,6,8,10) + dc(4,11)$

a) maxterm

wx \ yz	00	01	11	10
00	1 (0)	1 (1)	1 (3)	1 (2)
01	X (4)	1 (5)	0 (7)	1 (6)
11	0 (12)	0 (13)	0 (15)	0 (14)
10	1 (8)	0 (9)	X (11)	1 (10)

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

→ $(\bar{x}+\bar{y}+\bar{z})$

→ $\bar{w}+\bar{x}$

→ $\bar{w}+\bar{z}$

PI = $(\bar{x}+y+z)$, $(\bar{w}+\bar{z})$, $(\bar{w}+\bar{x})$, $(\bar{x}+\bar{y}+\bar{z})$

EPI = $(\bar{w}+\bar{z})$; $(\bar{w}+\bar{x})$, $(\bar{x}+\bar{y}+\bar{z})$

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

b) minterm:

wx \ yz	00	01	11	10
00	1 (0)	1 (1)	1 (3)	1 (2)
01	X (4)	1 (5)	0 (7)	1 (6)
11	0 (12)	0 (13)	0 (15)	0 (14)
10	1 (8)	0 (9)	X (11)	1 (10)

→ $\bar{x}yz$

→ $\bar{w}\bar{x}$

→ $\bar{w}\bar{z}$

$\bar{w}\bar{y}$

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

$w\bar{x}y$

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$PI = \bar{w}\bar{y}, \bar{x}\bar{z}, \bar{w}\bar{z}, \bar{w}\bar{x}, \bar{x}yz, w\bar{x}y$

$EPI = \bar{w}\bar{z}, \bar{x}\bar{z}, \bar{w}\bar{y}$

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

10/09/17

H.W

III.

1). $f(w,x,y,z) = \Pi M(7,9,12,13,14,15) + d(4,11)$

x ~~4 (10.~~ 4(0100)	(g1) (0100) (4) ✓			
7 (0111)	(g2) 1001 (9) ✓	g1 -100 (4,12) C		
9 (1001)	1100 (12) ✓	g2 10-1 (9,11) ✓	wxyz 1--1 (9,11,13,15)	
x 11 (1011)	g3 0111 (7) ✓	1-01 (9,13) ✓	1--1 (9,13,11,15)	
12 (1100)	1011 (11) ✓	110- (12,13) ✓	11-- (12,13,14,15)	
13 (1101)	1101 (13) ✓	11-0 (12,14) ✓	11-- (12,13,14,15)	
14 (1110)	1110 (14) ✓	g3 -111 (7,15) D		
15 (1111)	g4 1111 (15) ✓	1-11 (11,15) ✓		
		11-1 (13,15) ✓		
		111- (14,15) ✓		

$A = (\bar{w} + \bar{z})$

$B = (\bar{w} + \bar{x})$

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

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

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I) identify minterm & maxterm. canonical. expre.

1)

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

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

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

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

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

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

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

(A) $= \Sigma m(0,1,2,4,6)$ min. can. exp.

(B)

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

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

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

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

$= \Pi M(3,5,7)$ max. can. exp

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

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

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

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

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

$= \cancel{\Sigma m(4,5,7)}$ // $\Sigma m(3,4,7)$

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

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

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

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

$= \Pi M(0,1,2,5,6)$ //

II Using K-map solve.

1) $f(w,x,y,z) = \Sigma m(2,3,6,8,13,14,15) + dc(4,5,12)$

$\Pi M(0,1,7,9,10,11) + dc(4,5,12)$

(i) minterm

wx \ yz	00	01	11	10
00	0	0	1	1
01	X	X	0	1
11	X	1	1	1
10	1	0	0	0

$\bar{w}\bar{x}y$, $\bar{w}y\bar{z}$, $w\bar{y}$, wx, $w\bar{y}\bar{z}$

P.I = $w\bar{y}$, $w\bar{z}$, wx, $w\bar{y}\bar{z}$, $\bar{w}\bar{x}y$, $\bar{w}y\bar{z}$

EPI = $w\bar{y}\bar{z}$, wx, $\bar{w}\bar{x}y$

MS: $w\bar{y}\bar{z} + wx + \bar{w}\bar{x}y + w\bar{z}$

ii) maxterm

wx \ yz	00	01	11	10
00	0	0	1	1
01	x	x	0	1
11	x	1	1	1
10	1	0	0	0

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

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PI = $(\bar{w}+x+\bar{z}), (\bar{w}+x+\bar{y}), (w+\bar{x}+\bar{z}), (x+y+\bar{z}), (w+y)$

EPI = $(w+y), (w+\bar{x}+\bar{z}), (\bar{w}+x+\bar{y})$ ..

MP1 = $(w+y)(w+\bar{x}+\bar{z})(\bar{w}+x+\bar{y})(\bar{w}+x+\bar{z})$

MP2 = $(w+y)(w+\bar{x}+\bar{z})(\bar{w}+x+\bar{y})(x+y+\bar{z})$

28. $f(w,x,y,z) = \pi M(1,4,9,11,13) + dc(0,14,15)$

$\Sigma m(2,3,5,6,7,8,10,12) + dc(0,14,15)$

(i) minterm

$\bar{w}xz$ $\bar{w}y$

wx \ yz	00	01	11	10
00	X	0	1	1
01	0	1	1	1
11	1	0	X	X
10	1	0	0	

→ xy

$w\bar{z}$

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

$y\bar{z}$

PI = $w\bar{z}, \bar{x}\bar{z}, y\bar{z}, xy, \bar{w}y, \bar{w}xz$.

EPI = $w\bar{z}, \bar{w}xz$

MP = $w\bar{z} + \bar{w}xz + \bar{w}y$

(ii) maxterm

$(w+x+y)$

wx \ yz	00	01	11	10
00	X	0	1	1
01	0	1	1	1
11	1	0	X	X
10	1	0	0	1

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

$\bar{w}+\bar{z}$

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

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$P.I : (w+y+z), (x+y+\bar{z}), (\bar{w}+\bar{z}), (\bar{w}+x+y)$

$EPI : (\bar{w}+\bar{z}), (w+y+z)$

$MP1 = (\bar{w}+\bar{z})\cdot(w+y+z)\cdot\cancel{xy}(x+y+\bar{z})$ //

$MP2 = (\bar{w}+\bar{z})\cdot(w+y+z)\cdot\cancel{(x+y+\bar{z})}\cdot(w+x+y)$ //

11/09/

Chap. 03.

CLA adder - carry look ahead adder.

X Y C Sum C_{out}.

$Sum = x \oplus y \oplus C$

$C_{out} = xy + xc + yc$

10m

$= \underbrace{xy}_{(g)} + \underbrace{(x+y)}_{(p)} c.$ g → carry generation
p → " prop.

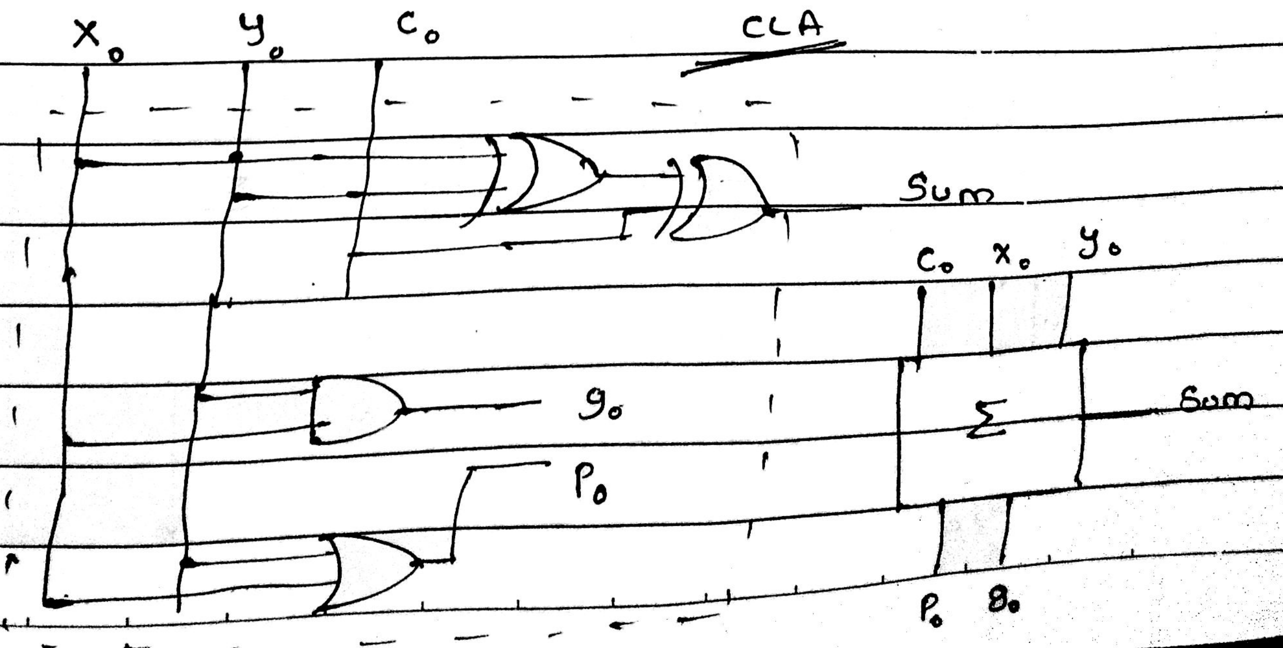
$C_1 = g_1 + P_1 C_0$

$C_2 = g_2 + P_2 C_1$

$= g_2 + p_2 (g_1 + p_1 c_0)$

$C_2 = g_2 + P_2 g_1 + P_2 P_1 C_0$

⋮



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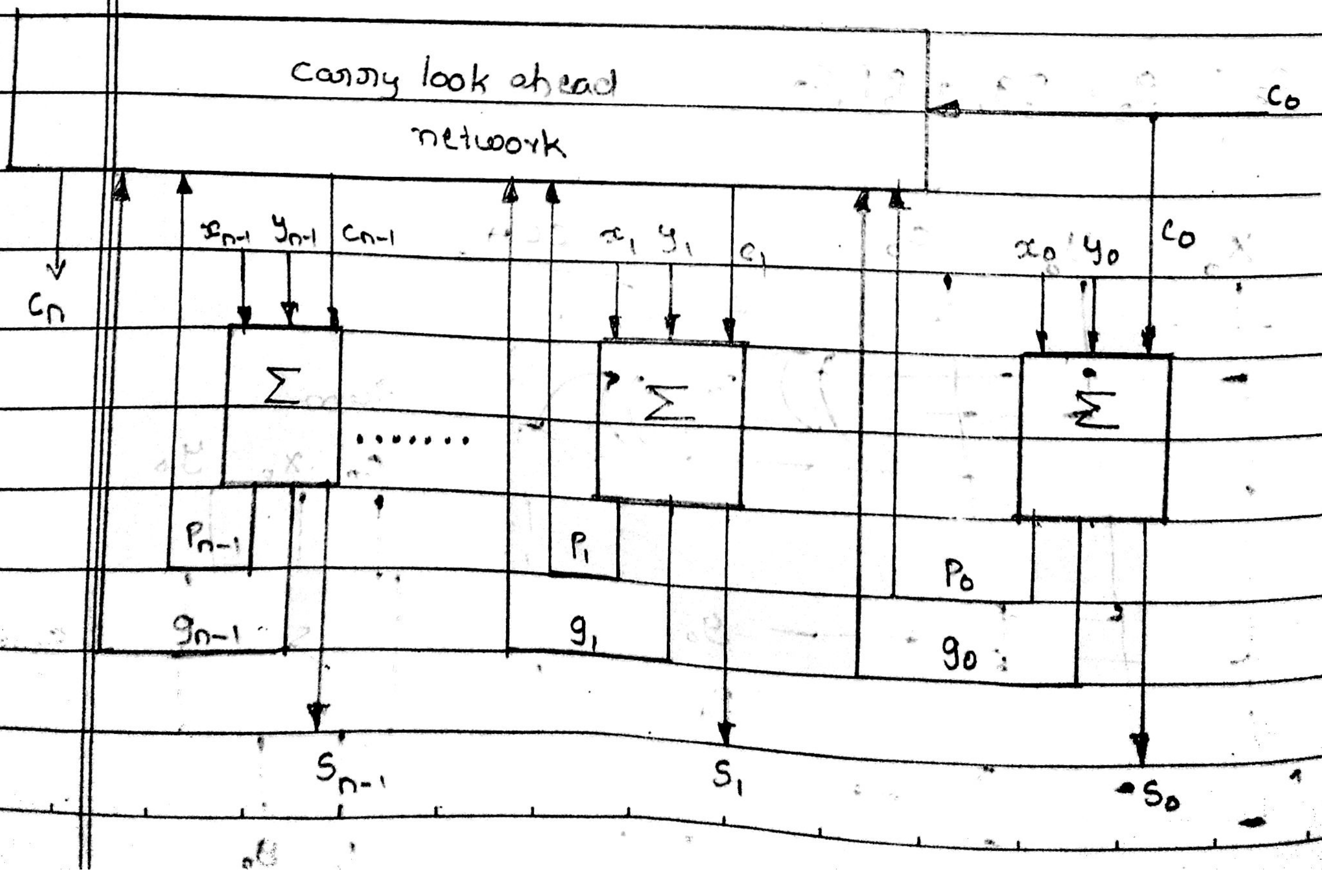
H.W. i) complete write-up.
ii) Σ-block diagram, (iii) draw. 23



P.g no. 239 (complete circuit)

draw it neatly

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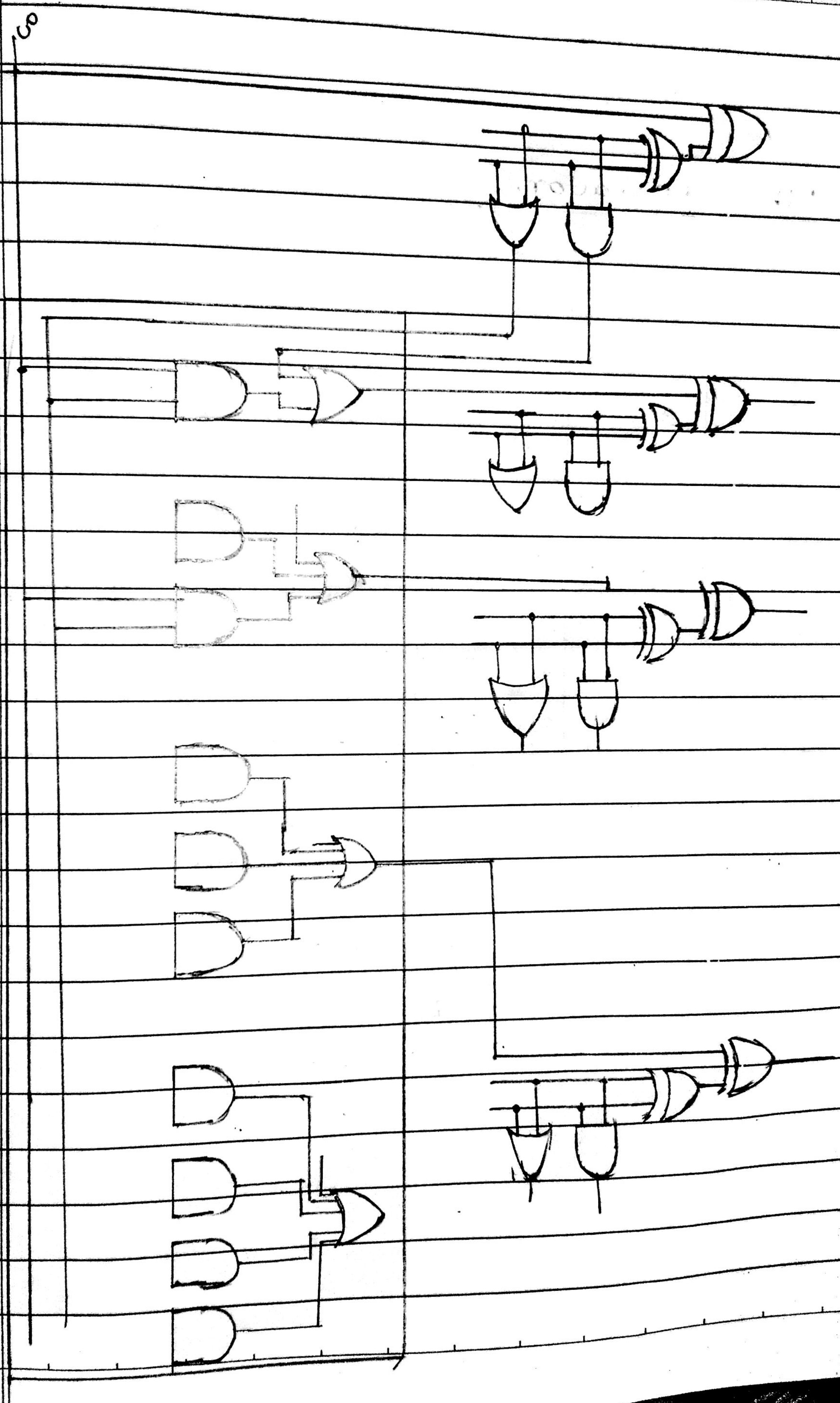
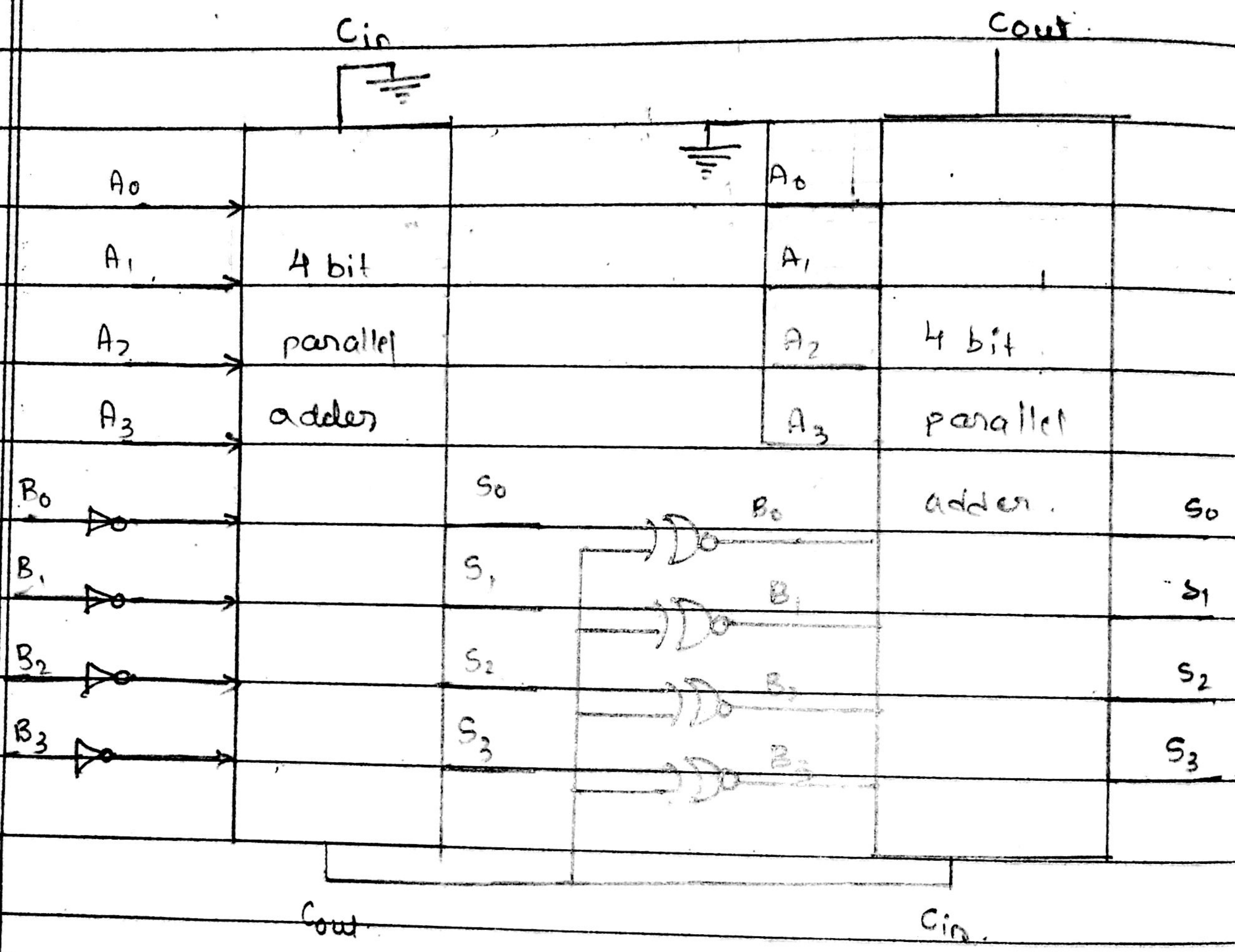


A → w x y z . (A − B).

B → a b c d.

BCD - substractor.



1-bit comparitor with history

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16	8	4	2	1			
A_i	B_i	G_i	E_i	L_i	G_{i+1}	E_{i+1}	L_{i+1}
0	0	0	0	0			
0	0	0	0	1			
0	0	0	1	0			
0	0	0	1	1			
0	0	1	0	0			
0	0	1	0	1			
0	0	1	1	0			
0	0	1	1	1			
0	1	0	0	0			
0	1	0	0	1			
0	1	0	1	0			
0	1	0	1	1			
0	1	1	0	0			
0	1	1	0	1			
0	1	1	1	0			
0	1	1	1	1			
1	0	0	0	0			
1	0	0	0	1			
1	0	0	1	0			
1	0	0	1	1			
1	0	1	0	0			
1	0	1	0	1			
1	0	1	1	0			
1	0	1	1	1			

Question : LSB & MSB of comparitor. using cascading

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A_i	B_i	G_i	E_i	L_i	G_{i+1}	E_{i+1}	L_{i+1}
1	~~0~~ 1	0	0	0	x	x	x
1	1	0	0	1	0	0	1
1	1	0	1	0	0	1	0
1	1	0	1	1	x	x	x
1	1	1	0	0	1	0	0
1	1	1	0	1	x	x	x
1	1	1	1	0	x	x	x
1	1	1	1	1	x	x	x

2 bit comparitor and design

H-W

A_1 A_0 B_1 B_0 G E L

$L_{i+1} = A_i\bar{B}_i + B_iL_i + \bar{A}_iL_i$

$E_{i+1} = \overline{A_iB_iE_i} + A_iB_iE_i$

$G_{i+1} = A_i\bar{B}_i + A_iG_i + \bar{B}_iG_i$

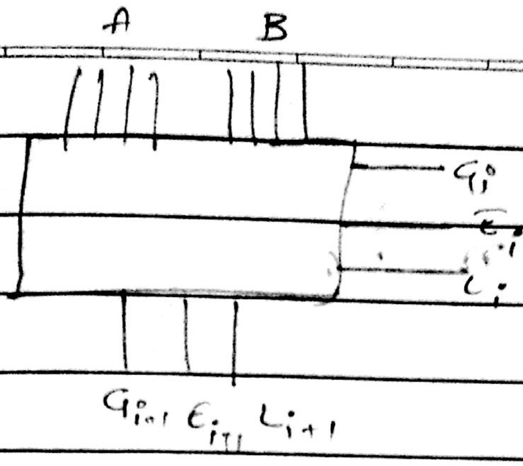
H-W → using 2 - 7485 → 5, 6, 7, 8

1 - " → " " " "

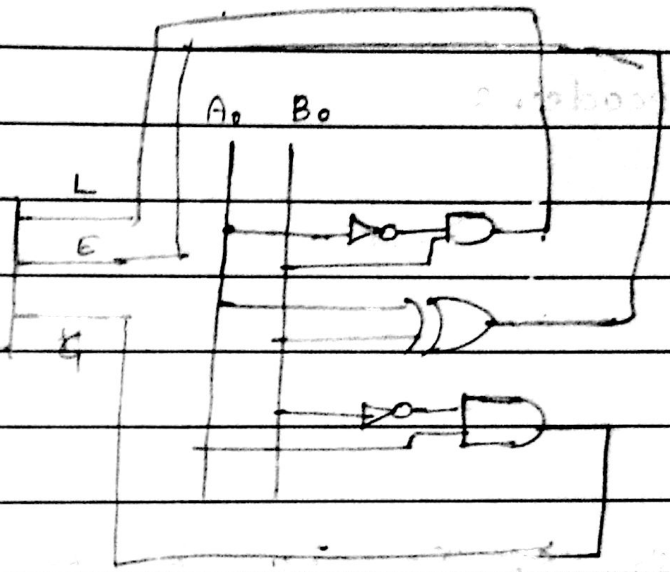
1 - 7485 → 1, 2, 3, 4

without using → 1, 2, 3, 4 (bits)

7485- 4-bit comparitor.



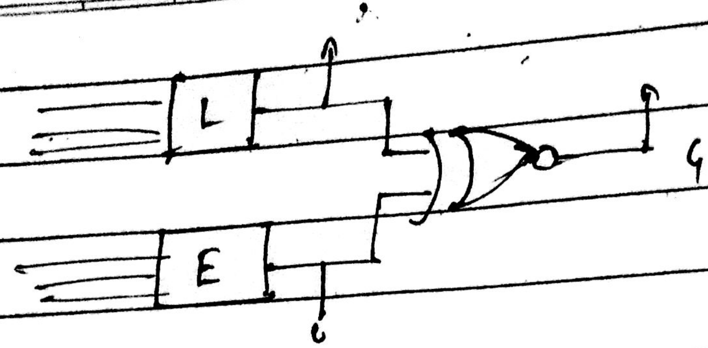
5-bit comparitor with 1 - 7485.



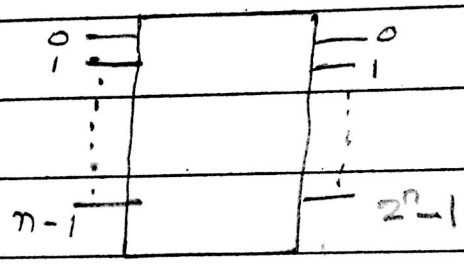
Tip: To derive o/p from o/p.

L	E	G
0	0	1
0	1	0
1	0	0
1	1	X

$G = \overline{L \oplus E}$



Decoder : (Refer the book)



x_2	x_1	x_0	z_0	z_1	z_2	z_3	z_4	z_5	z_6	z_7
0	0	0	1	0	0	0	0	0	0	0
0	0	1	0	1	0	0	0	0	0	0
0	1	0	0	0	1	0	0	0	0	0
0	1	1	0	0	0	1	0	0	0	0
1	0	0	0	0	0	0	1	0	0	0
1	0	1	0	0	0	0	0	1	0	0
1	1	0	0	0	0	0	0	0	1	0
1	1	1	0	0	0	0	0	0	0	1

$z_0 = \bar{x}_2 \bar{x}_1 \bar{x}_0$

$z_1 = \bar{x}_2 \bar{x}_1 x_0$

$z_2 = \bar{x}_2 x_1 \bar{x}_0$

$z_3 = \bar{x}_2 x_1 x_0$

$z_4 = x_2 \bar{x}_1 \bar{x}_0$

$z_5 = x_2 \bar{x}_1 x_0$

$z_6 = x_2 x_1 \bar{x}_0$

$z_7 = x_2 x_1 x_0$

x_2	x_1	x_0	z_0	z_1	z_2	z_3	z_4	z_5	z_6	z_7
0	0	0	0	1	1	1	1	1	1	1
0	0	1								
0	1	0								
0	1	1								
1	0	0								
1	0	1								
1	1	0								
1	1	1								

$z_0 = \overline{\bar{x}_2 \cdot \bar{x}_1 \bar{x}_0}$

$z_1 = \overline{\bar{x}_2 \bar{x}_1 x_0}$

$z_2 = \overline{\bar{x}_2 x_1 \bar{x}_0}$

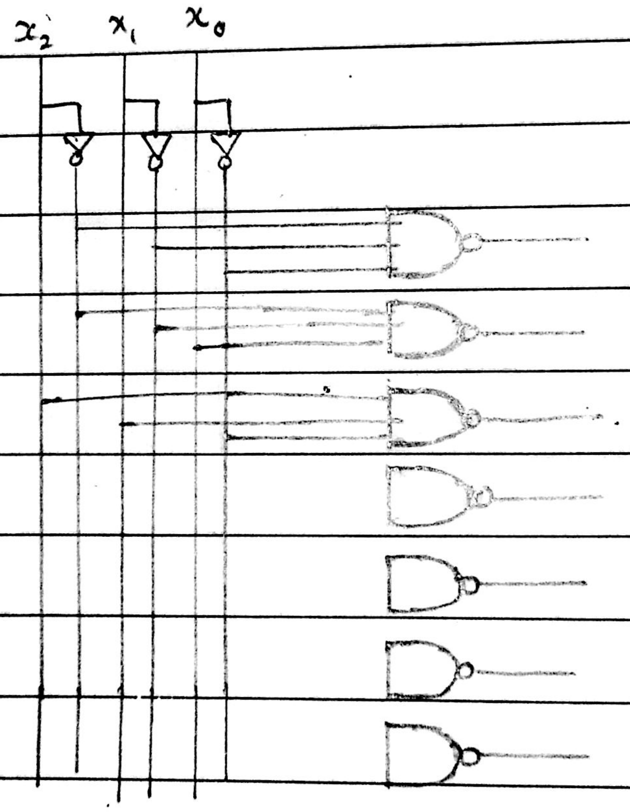
$z_3 =$

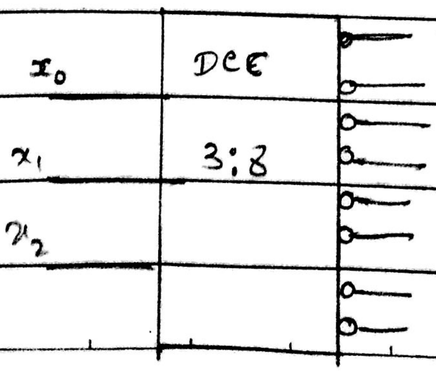
$z_4 =$

$z_5 =$

$z_6 =$

$z_7 =$





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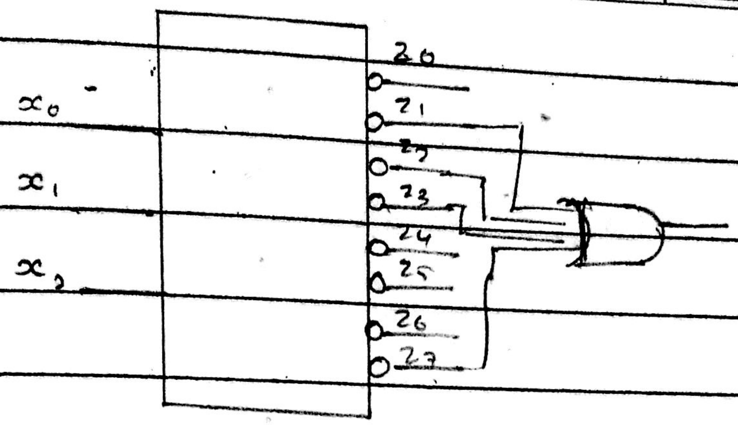
Ex: $\Pi M(1, 2, 3, 7)$



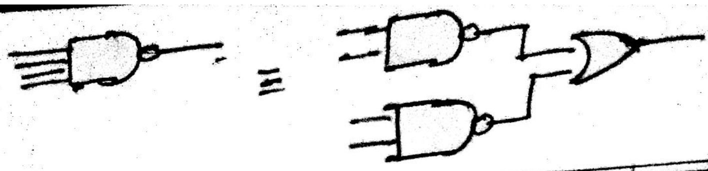
Full adder using decoder

H.W

A	B	C_i	Sum	C_{out}
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

Sum : ~~ΠM~~ : (0, 3, 5, 6)

~~dif~~ Cout : (0, 1, 2, 4).



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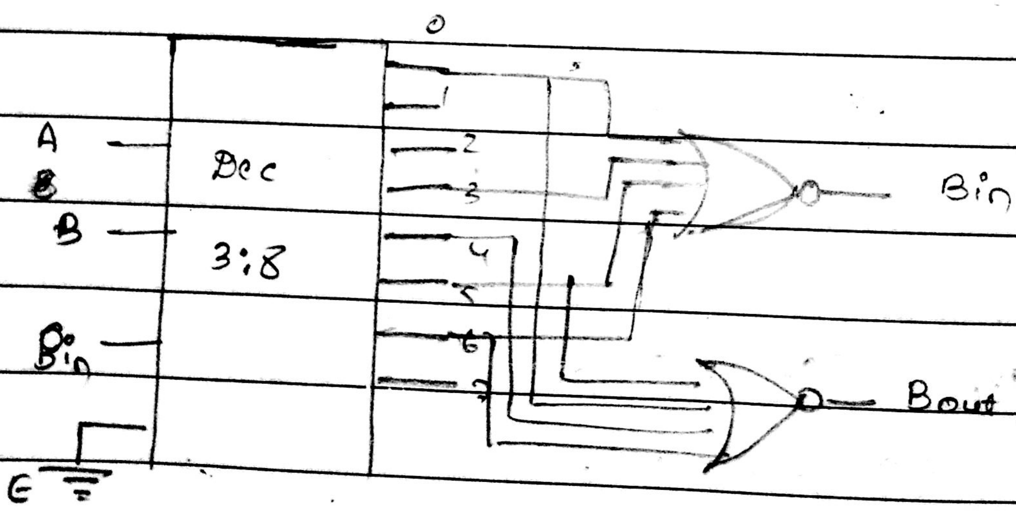
Full substractor.

A	B	Bin	Dif	Bout
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	0	1
1	0	0	1	0
1	0	1	0	0
~~0~~1	1	0	0	0
1	1	1	1	1

Diff = $f(A, B, B_{in}) = \Pi M(0, 3, 5, 6)$

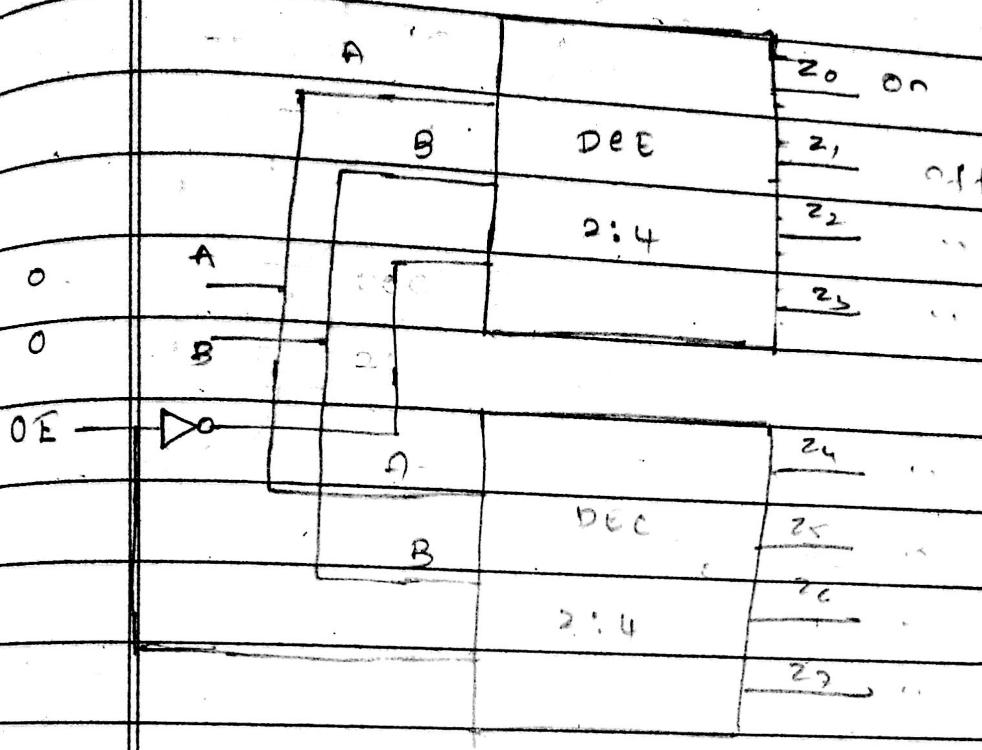
Bout = $f(A, B, B_{in}) = \Pi M(0, 4, 5, 6)$



A

74LS139. (maxterm generator. decoder)

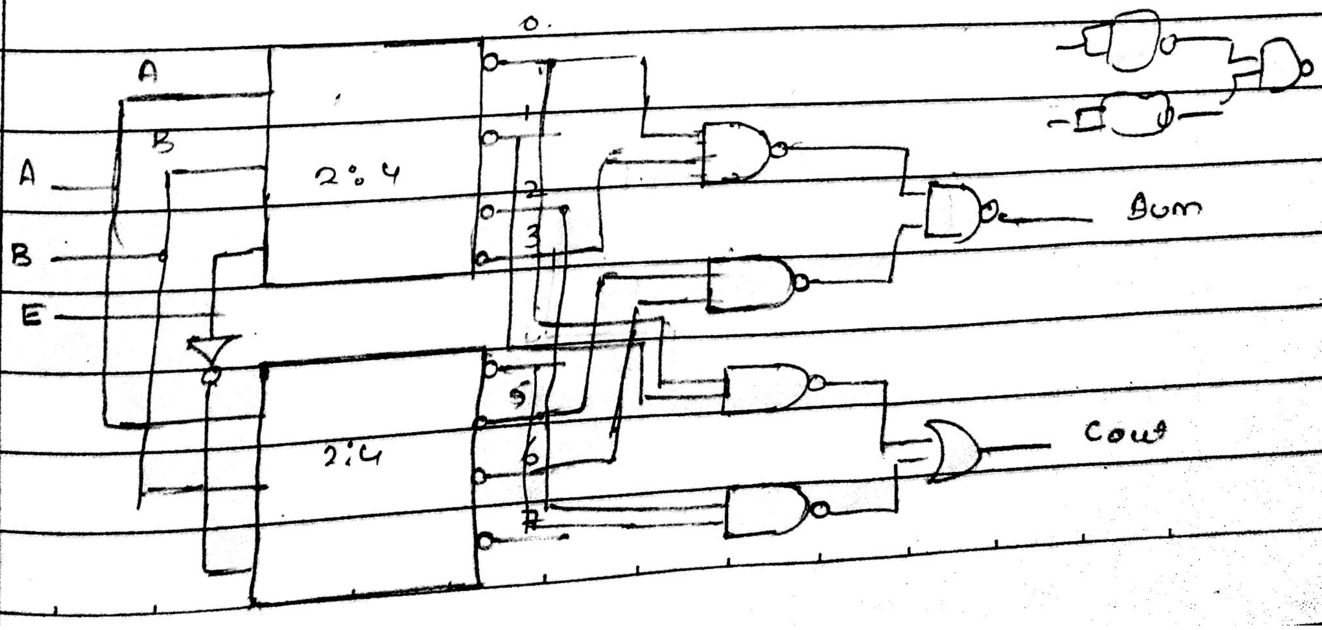
create. 3:8 using. 2:4



1) Design full adder and and full substrator using maxterm generator of size 2:4. using externa-l 2. i/p. NAND gates only.

$AD = \Pi M(0, 3, 5, 6) = \Sigma m(1, 2, 4, 7)$

$C_{out} = \Pi M(0, 1, 2, 4) = \Sigma m(3, 5, 6, 7)$.

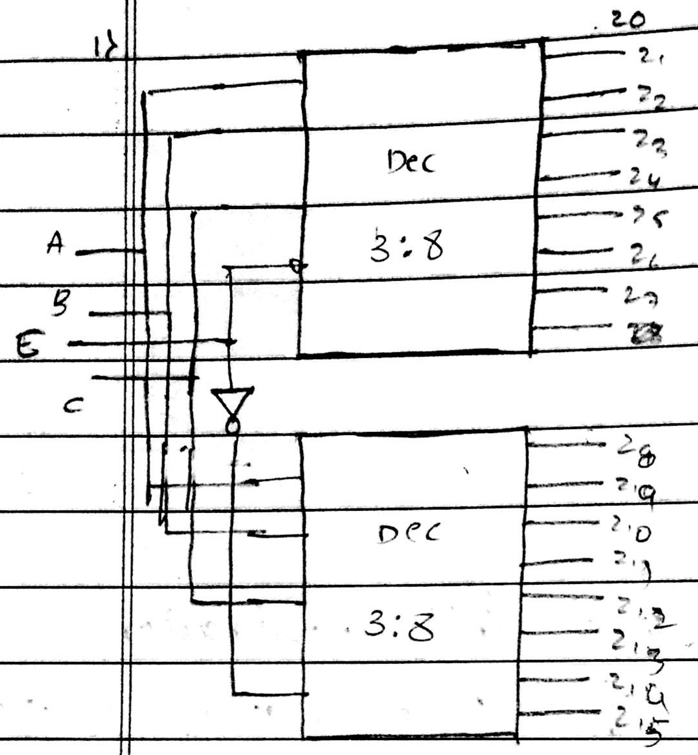


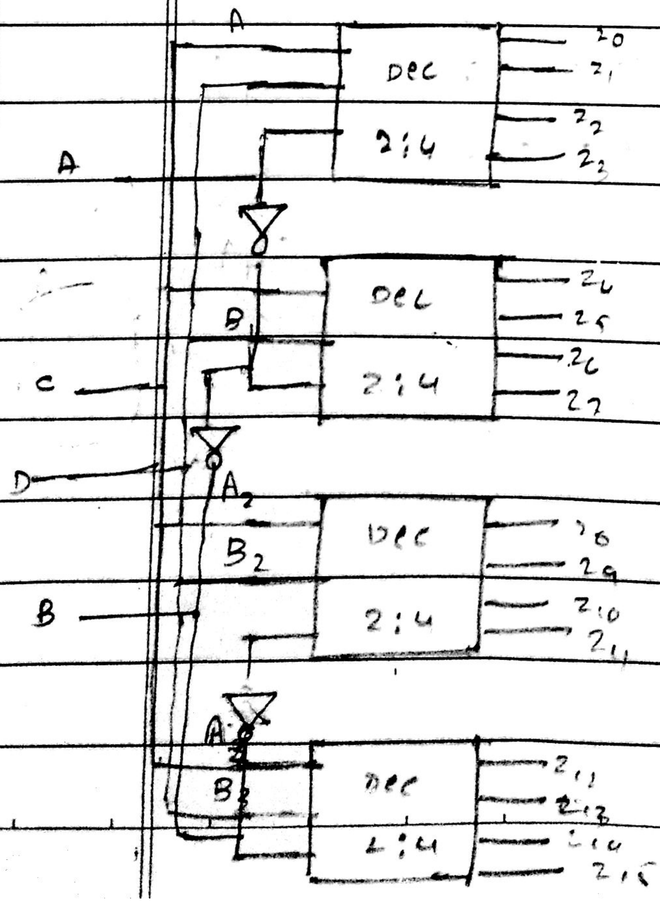
H.W.

1) Realize 4:16 decoder using 3:8 decoders.

2) Realize 4:16 " " only 2:4 decoders.

1)





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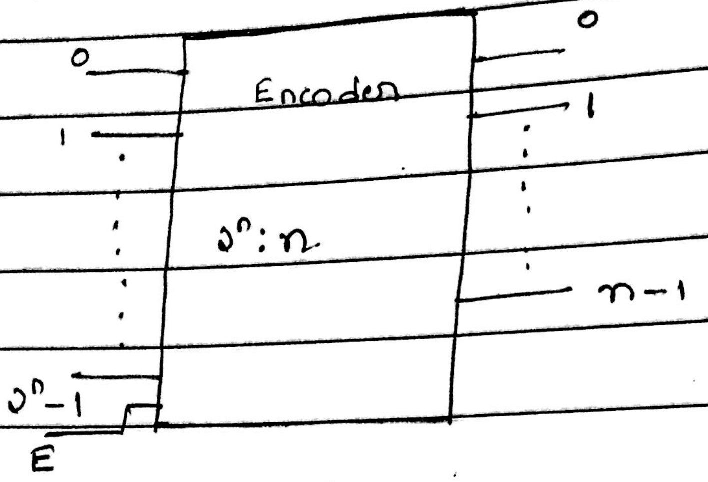
A	B	C	D
0	0	0	0
0	0	0	1
0	0	1	0
0	0	1	1
0	1	0	0
0	1	0	1
0	1	1	0
0	1	1	1
1	0	0	0
1	0	0	1
1	0	1	0
1	0	1	1
1	1	0	0
1	1	0	1
1	1	1	0
1	1	1	1

16/09/17

Encoders

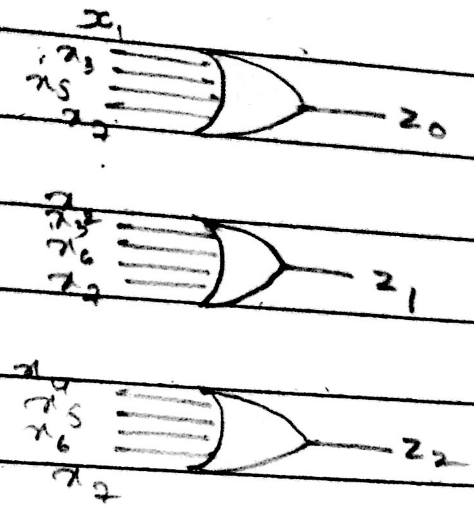


x_0	x_1	x_2	x_3	x_4	x_5	x_6	x_7	Z_0	Z_1	Z_2	E
0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	1
X	1	0	0	0	0	0	0	0	0	1	1
X	X	1	0	0	0	0	0	0	1	0	1
X	X	X	1	0	0	0	0	0	1	1	1
X	X	X	X	1	0	0	0	~~0~~ 1	0	0	1
X	X	X	X	X	1	0	0	1	0	1	1
X	X	X	X	X	X	1	0	1	1	0	1
X	X	X	X	X	X	X	1	1	1	1	1

$Z_0 = x_1 + x_3 + x_5 + x_7$

$Z_1 = x_2 + x_3 + x_6 + x_7$

$Z_2 = x_4 + x_5 + x_6 + x_7$


x1
x3
x5
x7
z0
x2
x3
x6
x7
z1
x4
x5
x6
x7
z2