INDRAPRASTHA INSTITUTE OF INFORMATION TECHNOLOGY, DELHI

ECE111 Digital Circuits

Practice problems 1

Q.1 Show that different realizations given Fig. 1(a), 1(b) and 1(c) result in same output.

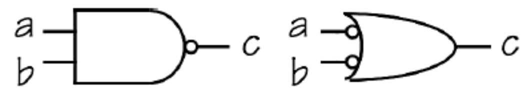


Fig. 1(a)

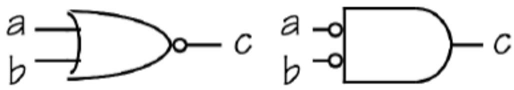


Fig. 1(b)

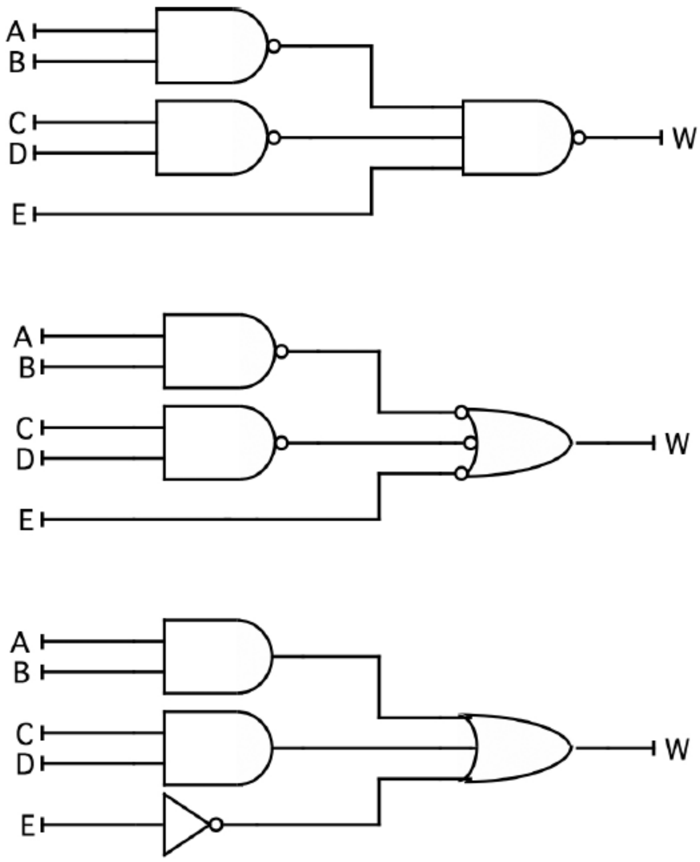


Fig. 1(c)

Q.2 Realize W = AB + CD + EF using 2-input NAND gates only

Q.3 Show that $\bar{W}\,\bar{Y} + W\bar{Y} + XY = X + \bar{Y}$ using Boolean algebra axioms and verify this by using truth table.

Q,4 Find the output for the logic circuit given in Fig. 2(a) – 2(e)

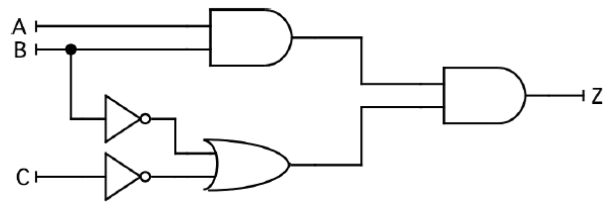


Fig. 2(a)

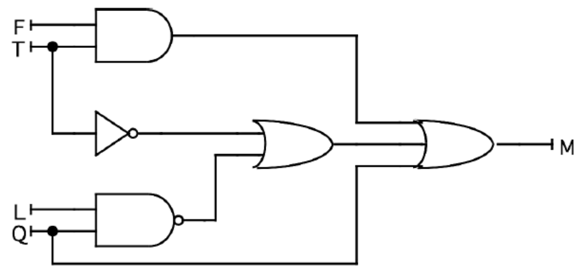


Fig. 2(b)

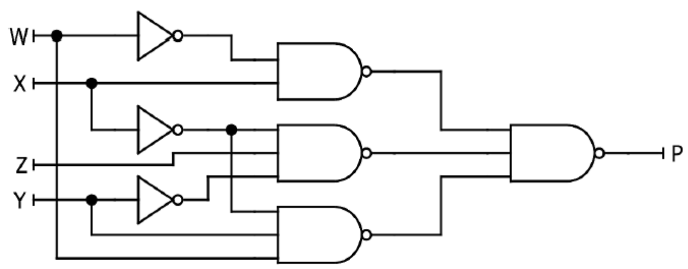


Fig. 2(c)

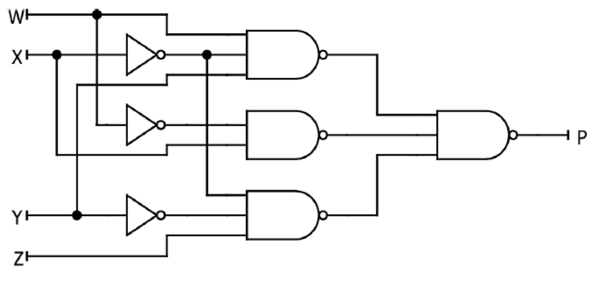


Fig. 2(d)

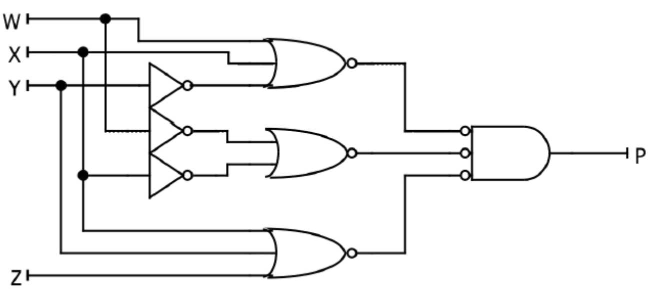
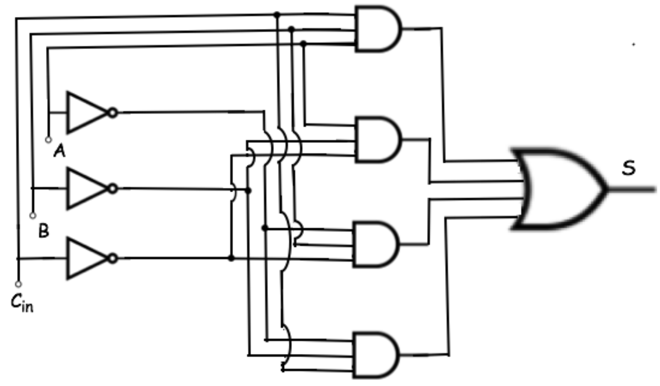


Fig. 2(e)

5. For the circuits given write the expression for the output S and C of the circuits given below and also obtain the corresponding Truth Tables:



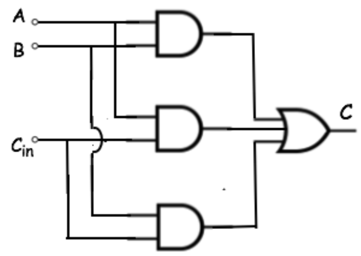


Fig. 3

6. For the above circuit draw the timing diagram with ABC going through the values 000, 001, 010, 011, 100, 101, 110, 111, 000.

7. Verify the following expressions with the help of truth Table:

   (i) A + AB’ + ABC’ = A#

   (ii) x.y + x'z + y.z = x.y + x'.z

8. Show the following equivalences using Boolean Algebra Axioms and verify with Truth Table.

   $(i)\ \ A + A\bar{B} + AB\bar{C} = A \qquad (ii)\ \ x.y + y.z + \bar{x}.z\ = x.y + \bar{x}.z \qquad (iii)\ \ x + \bar{x}.y\ = x + y$

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DC

Practice Problem 1

Q1 a)

$c = \overline{a \cdot b}$

$= \bar{a} + \bar{b}$

(By demorgan's law)

$c = \bar{a} + \bar{b}$

b)

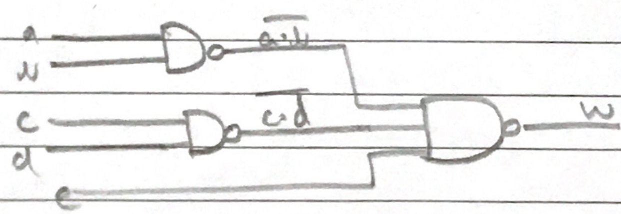
$c = \overline{a + b}$

$= \bar{a} \cdot \bar{b}$

(Demorgan's law)

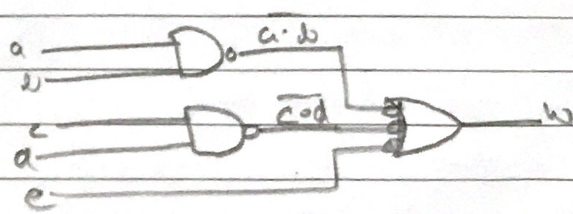
$c = \bar{a} \cdot \bar{b}$

c)



$w = \overline{\overline{a \cdot b} \cdot \overline{c \cdot d} \cdot e}$

$= a \cdot b + c \cdot d + \bar{e}$ (Demorgan's law)



$w = \overline{\overline{a \cdot b}} + \overline{\overline{c \cdot d}} + \bar{e}$

$= a \cdot b + c \cdot d + \bar{e}$

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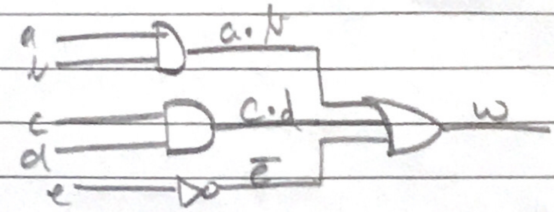
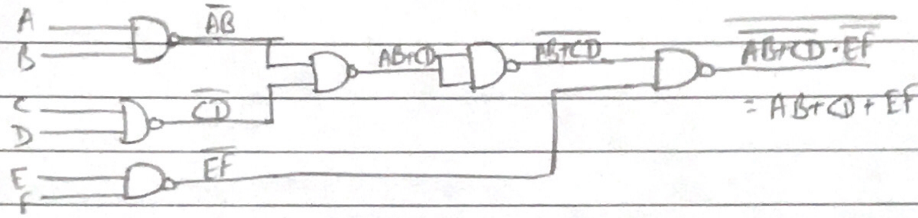


$w = a\cdot b + c\cdot d + \overline{e}$

Q2

$W = AB + CD + EF$ using ~~an~~ 2-input NAND gates only



Q3 $\overline{w}\overline{y} + w\overline{x} + xy = x+\overline{y}$

LHS

$\overline{w}\overline{y} + w\overline{y} + xy = \overline{y}(w+\overline{w}) + xy = \overline{y} + xy\cdot 1$

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

$\cancel{= x + \overline{x}\overline{y}} \qquad \cancel{= x +}$

$\cancel{= \overline{y} + xy(\overline{y}+y)}$

$\cancel{= \overline{y} + xy(\overline{y}+y)}$

$\cancel{= \overline{y} + xy\overline{y} + xyy}$

$\cancel{=}$

$\cancel{1\cdot\overline{y} + xy = (y+\overline{y})\overline{y} + xy = y}$

$1\cdot\overline{y} + xy = (1+x)\overline{y} + xy = \overline{y} + x\overline{y} + xy$

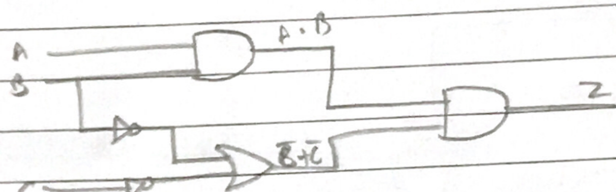
$= \overline{y} + x(y+\overline{y})$

$= \overline{y} + x$

x	y	w	$\overline{y}$	$\overline{w}\,\overline{y}$	$w\overline{y}$	xy	$\overline{w}\,\overline{y} + w\overline{y} + xy$	$x + \overline{y}$
0	0	0	1	1	0	0	1	1
0	0	1	1	0	1	0	1	1
0	1	0	0	0	0	0	0	0
0	1	1	0	0	0	0	0	0
1	0	0	1	1	0	0	1	1
1	0	1	1	0	1	0	1	1
1	1	0	0	0	0	1	1	1
1	1	1	0	0	0	1	1	1

Q4

a)

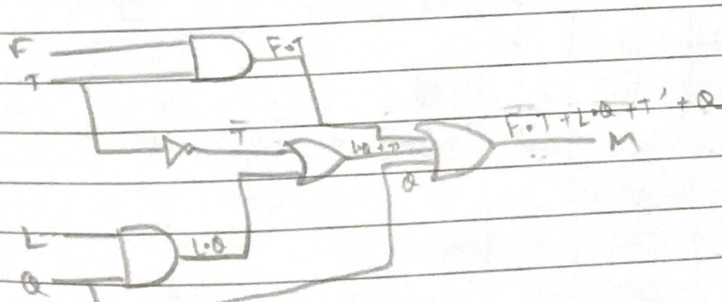


$$Z = A \cdot B \cdot (\overline{B} + \overline{C})$$

$$= \underbrace{A \cdot B \cdot \overline{B}}_{0} + AB\overline{C}$$

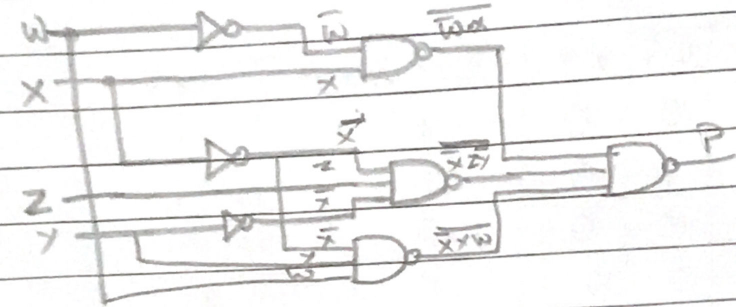
$$= AB\overline{C}$$

b)



$$M = F \cdot T + L \cdot Q + T' + Q$$

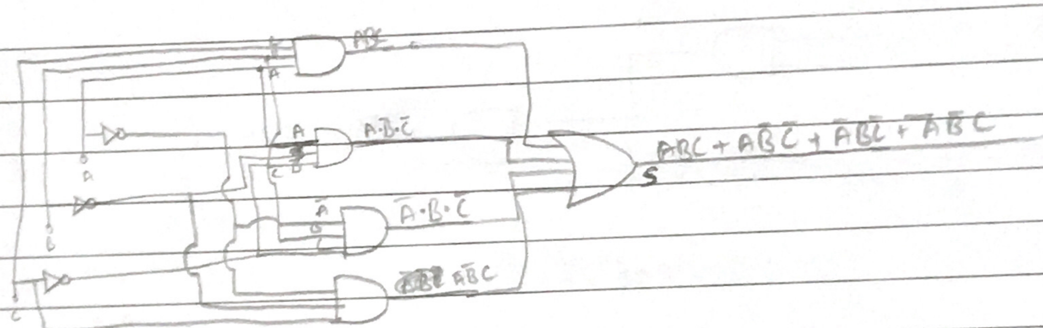
i)



$$P = \overline{\overline{\overline{W}\cdot X} \cdot \overline{\overline{X}Z\overline{Y}} \cdot \overline{\overline{X}YW}}$$

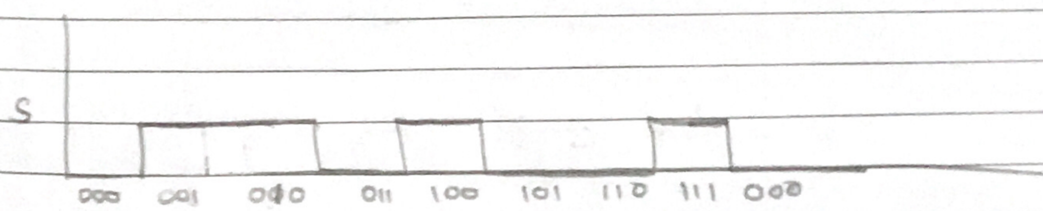
$$P = \overline{W}\cdot X + \overline{X}\cdot Z\cdot\overline{Y} + \overline{X}\cdot Y\cdot W$$

Q5



A	B	C	$\overline{A}$	$\overline{B}$	$\overline{C}$	ABC	$A\overline{B}\overline{C}$	$\overline{A}B\overline{C}$	$\overline{A}\overline{B}C$	$ABC + A\overline{B}\overline{C} + \overline{A}B\overline{C} + \overline{A}\overline{B}C$
0	0	0	1	1	1	0	0	0	0	0
0	0	1	1	1	0	0	0	0	1	1
0	1	0	1	0	1	0	0	1	0	1
0	1	1	1	0	0	0	0	0	0	0
1	0	0	0	1	1	0	1	0	0	1
1	0	1	0	1	0	0	0	0	0	0
1	1	0	0	0	1	0	0	0	0	0
1	1	1	0	0	0	1	0	0	0	1

Q6



Q2 ii) $x \cdot y + y \cdot z + \bar{x} \cdot z = x \cdot y + \bar{x} \cdot z$

LHS

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

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

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

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

$= xy(1+z) + \bar{x}z(1+y)$ $\qquad \because (1+a=1)$

$= xy + \bar{x}z$

$= RHS$

H.P

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

LHS

~~x+x~~

$1 \cdot x + \bar{x}y$

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

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

$= x + y(x + \bar{x})$ $\qquad \because a + \bar{a} = 1$

$= x + y$

$= RHS$

H.P