Tutorial-4.

Q1 Find the dual of following expressions/functions.

(a) $AB + \overline{AC} + A\overline{B}C$

(b) $\overline{X}Z + \overline{X}Y + X\overline{Y}Z + YZ$

(c) $(A+B+E+F)(A+B+E+\overline{F})(\overline{A}+\overline{B}+E+F)$

(d) $(\overline{X}+Y+Z)(X+\overline{Y}+\overline{Z})(X+Y+Z)(X+Y+\overline{Z})$

Q2 Reduce the expressions.

(a) $f_1 = A[B+\overline{C}(\overline{AB+A\overline{C}})]$

(b) $f_2 = \overline{(A+\overline{BC})}(A\overline{B}+ABC)$

Q3 Show the following.

(a) $A\overline{B}C + B + B\overline{D} + AB\overline{D} + \overline{A}C = B+C$

(b) $AB + A\overline{B}C + B\overline{C} = AC + B\overline{C}$

Q4 Using truth table prove the following laws.

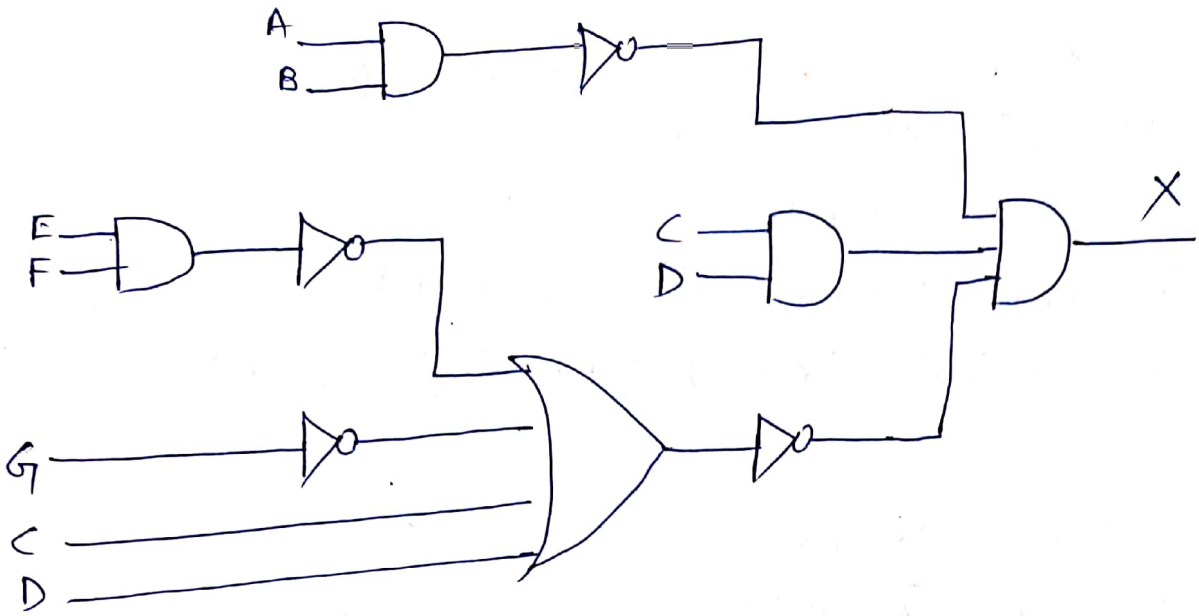
(a) $A+BC = (A+B)(A+C)$

(b) $(A+B)\overline{AB} = A \oplus B$

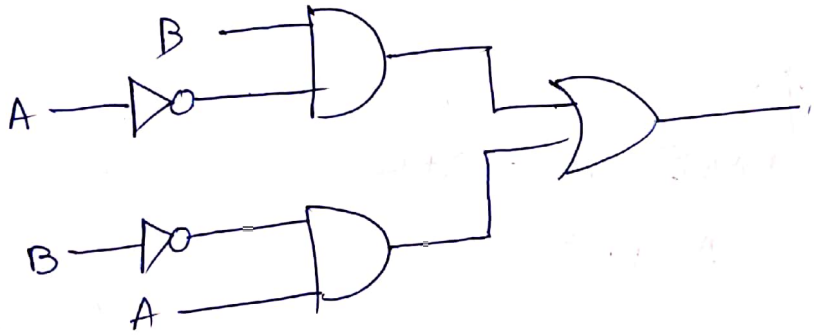
Q5 Convert the following boolean expression into logic gates. (Use only AND, OR, NOT gate)

$\overline{AB} + A + \overline{B+C}$

Q6 Convert the following logic diagram to it's equivalent boolean expression(X).



Q7 Draw the following circuit using (a) NAND gates only.
(b) NOR gates only



Q8 Realize X-OR function using (a) NAND logic
(b) NOR logic.

Q9 How many gate inputs are required to realize the following expression? How many two-input AND and OR gates are required to implement the same in hardware.

(a) $f_1 = ABC + A\bar{B}CD + E\bar{F} + AD$

(b) $f_2 = A(B+C+\bar{D})(\bar{B}+C+\bar{E})(A+\bar{B}+C+E)$

Tutorial-4 (Solutions)

Q1) (a) $(A+B)\overline{(A+C)}(A+\overline{B}+C)$

(b) $(\overline{X}+Z)(\overline{X}+Y)(X+\overline{Y}+Z)(Y+Z)$

(c) $ABEF + AB\overline{E}\,\overline{F} + \overline{A}\,\overline{B}EF$

(d) $\overline{X}YZ + X\overline{Y}\,\overline{Z} + XYZ + XY\overline{Z}$

Q2) (a) $f_1 = A[B + \overline{C}(\overline{AB + A\overline{C}})]$

$= A[B + \overline{C}(\overline{AB}\cdot\overline{A\overline{C}})]$ Demorgan's law

$= A[B + \overline{C}(\overline{A}+\overline{B})(\overline{A}+C)]$ Demorgan's law

$= A[B + \overline{C}(\overline{A}\,\overline{A} + \overline{A}C + \overline{B}\,\overline{A} + \overline{B}C)]$

$= A[B + \overline{C}\,\overline{A} + \overline{C}\,\overline{A}C + \overline{C}\,\overline{B}\,\overline{A} + \overline{C}\,\overline{B}C)$

$= A[B + \overline{C}\,\overline{A} + 0 + \overline{C}\,\overline{B}\,\overline{A} + 0)$

$= AB + A\overline{C}\,\overline{A} + A\overline{C}\,\overline{B}\,\overline{A}$

$= AB + 0 + 0$

$= AB$

(b) $f_2 = (\overline{A + \overline{BC}})(A\overline{B} + ABC)$

$= (\overline{A}\;\overline{\overline{BC}})(A\overline{B} + ABC)$ Demorgan's law

$= (\overline{A}BC)(A\overline{B} + ABC)$

$= \overline{A}BCA\overline{B} + \overline{A}BCABC$

$= A\overline{A}B\overline{B}C + A\overline{A}BBCC$

$= 0 + 0$

$= 0$

Q3) (a) $A\bar{B}C + B + B\bar{D} + AB\bar{D} + \bar{A}C$

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

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

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

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

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

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

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

$= B + C$

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

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

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

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

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

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

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

$= AC + B\bar{C}$

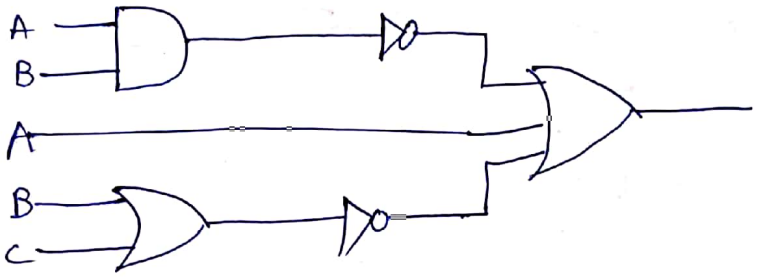
Q4) (a)

A	B	C	BC	A+BC	A+B	A+C	(A+B)(A+C)
0	0	0	0	0	0	0	0
0	0	1	0	0	0	1	0
0	1	0	0	0	1	0	0
0	1	1	1	1	1	1	1
1	0	0	0	1	1	1	1
1	0	1	0	1	1	1	1
1	1	0	0	1	1	1	1
1	1	1	1	1	1	1	1

(b)

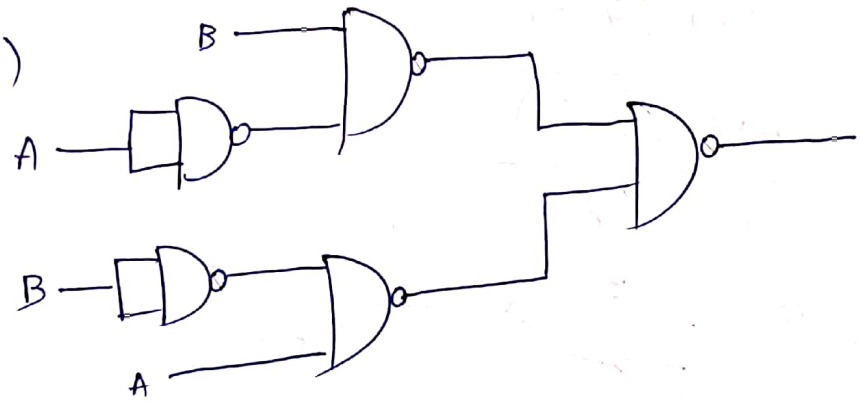
A	B	$A \oplus B$	$A + B$	$\overline{AB}$	$\overline{A+B}$	$(A+B)(\overline{AB})$
0	0	0	0	1	1	0
0	1	1	1	1	0	1
1	0	1	1	1	0	1
1	1	0	1	0	0	0

Q5

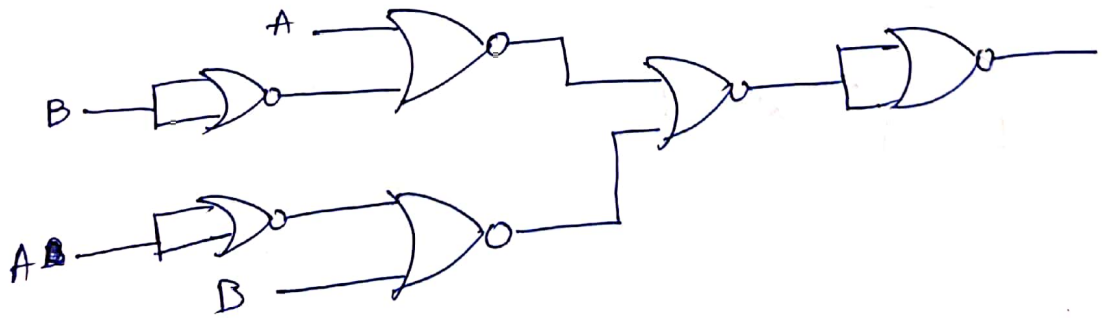


Q6 $\overline{AB} \cdot (CD) \cdot \overline{(C+D+\overline{EF}+\overline{G})}$

Q7 (a)



(b)



Q8) (a) $X = A\overline{B} + \overline{A}B$

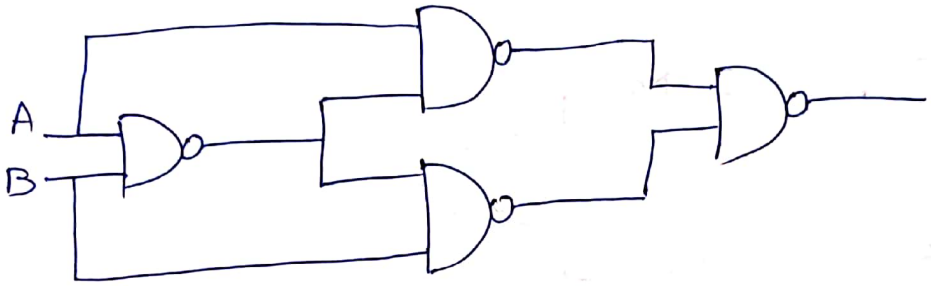
$= A\overline{A} + A\overline{B} + \overline{A}B + B\overline{B}$

$= A(\overline{A}+\overline{B}) + B(\overline{A}+\overline{B})$

$= A\overline{AB} + B\overline{AB}$

$= \overline{A\overline{AB}} + \overline{B\overline{AB}}$

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



(b) $X = A\overline{B} + \overline{A}B$

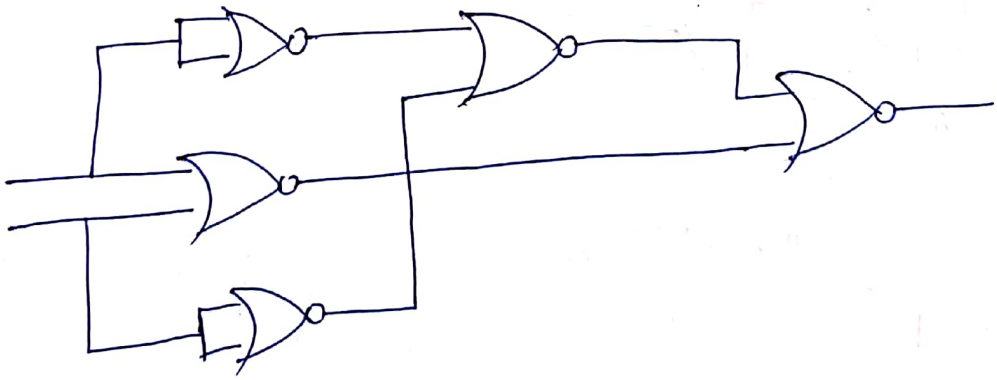
$= A\overline{A} + A\overline{B} + \overline{A}B + B\overline{B}$

$= A(\overline{A}+\overline{B}) + B(\overline{A}+\overline{B})$

$= (A+B)(\overline{A}+\overline{B})$

$= \overline{(A+B)(\overline{A}+\overline{B})}$

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



(5)

(a)

Count the AND i/ps = 11

Count the AND gates feeding the OR gate = 4

total gate i/ps = 15

# of 2 i/p AND gates = 7

# of 2 i/p OR gates = 3

(b)

Count the OR i/ps = 10

Count the OR gates feeding the AND gate = 4

total gate i/ps = 14

# of 2 i/p OR gates = 7

# of 2 i/p AND gates = 3