15)

a) AND
$$\frac{\begin{array}{r}10101100\\11000101\end{array}}{10000100}$$

b) AND
$$\frac{\begin{array}{r}00100010\\11111101\end{array}}{00100000}$$

c) OR
$$\frac{\begin{array}{r}10101100\\11000101\end{array}}{11101101}$$

d) OR
$$\frac{\begin{array}{r}00100010\\11111101\end{array}}{11111111}$$

e) XOR
$$\frac{\begin{array}{r}10101100\\11000101\end{array}}{01101001}$$

f) XOR
$$\frac{\begin{array}{r}00100010\\11111101\end{array}}{11011111}$$

g) NOT $00101100 = 11010011$ h) NOT $11000101 = 00111010$

i) NAND
$$\frac{\begin{array}{r}10101011\\11000101\end{array}}{01111110}$$

j) NAND
$$\frac{\begin{array}{r}00100010\\11111101\end{array}}{11011111}$$

k) NOR
$$\frac{\begin{array}{r}10101110\\11010101\end{array}}{00000000}$$

l) NOR
$$\frac{\begin{array}{r}00101010\\11100101\end{array}}{00010000}$$

m) XNOR
$$\frac{\begin{array}{r}10101100\\11000101\end{array}}{01010110}$$

n) XNOR
$$\frac{\begin{array}{r}10101100\\11111101\end{array}}{10101110}$$

16)

a) OR

X_7	X_6	X_5	X_4	X_3	X_2	X_1	X_0
1	0	1	0	1	0	1	0
1	X_6	1	X_4	1	X_2	1	X_0

b) OR

X_7	X_6	X_5	X_4	X_3	X_2	X_1	X_0
1	1	1	1	1	0	0	0
1	1	1	1	1	X_2	X_1	X_0

c) AND

X_7	X_6	X_5	X_4	X_3	X_2	X_1	X_0
1	0	1	0	1	0	1	0
X_7	0	X_5	0	X_3	0	X_1	0

d) AND

X_7	X_6	X_5	X_4	X_3	X_2	X_1	X_0
1	0	0	0	1	1	1	1
X_7	0	0	0	X_3	X_2	X_1	X_0

e) XOR

X_7	X_6	X_5	X_4	X_3	X_2	X_1	X_0
1	0	1	0	1	0	1	0
$\overline{X_7}$	X_6	$\overline{X_5}$	X_4	$\overline{X_3}$	X_2	$\overline{X_1}$	X_0

f) XOR

X_7	X_6	X_5	X_4	X_3	X_2	X_1	X_0
0	0	0	0	1	1	1	1
X_7	X_6	X_5	X_4	$\overline{X_3}$	$\overline{X_2}$	$\overline{X_1}$	$\overline{X_0}$

g) OR

X_7	X_6	X_5	X_4	X_3	X_2	X_1	X_0
1	0	0	0	0	0	0	0

AND

1	X_6	X_5	X_4	X_3	X_2	X_1	X_0
1	1	1	1	0	0	0	0

XOR

1	X_6	X_5	X_4	0	0	0	0
0	0	0	1	1	1	1	0
1	X_6	X_5	$\overline{X_4}$	1	1	1	0

h) AND

X_7	X_6	X_5	X_4	X_3	X_2	X_1	X_0
1	0	1	0	1	1	1	1

OR

X_7	0	X_5	0	X_3	X_2	X_1	X_0
1	1	1	1	0	0	0	0

XOR

1	1	1	1	X_3	X_2	X_1	X_0
0	0	0	1	1	1	1	0
1	1	1	0	$\overline{X_3}$	$\overline{X_2}$	$\overline{X_1}$	X_0

i) XOR

X_7	X_6	X_5	X_4	X_3	X_2	X_1	X_0
1	0	1	0	1	0	1	0

AND

$\overline{X_7}$	X_6	$\overline{X_5}$	X_4	$\overline{X_3}$	X_2	$\overline{X_1}$	X_0
1	1	1	1	0	0	0	0

OR

$\overline{X_7}$	X_6	$\overline{X_5}$	X_4	0	0	0	0
0	0	0	1	1	1	1	0
$\overline{X_7}$	X_6	$\overline{X_5}$	1	1	1	1	0

j) XNOR

X_7	X_6	X_5	X_4	X_3	X_2	X_1	X_0
1	0	1	0	1	0	1	0

NAND

$\overline{X_7}$	X_6	$\overline{X_5}$	X_4	$\overline{X_3}$	X_2	$\overline{X_1}$	X_0
1	1	1	1	0	0	0	0

NOR

$\overline{X_7}$	X_6	$\overline{X_5}$	X_4	0	0	0	0
0	0	0	1	1	1	1	0
$\overline{X_7}$	X_6	$\overline{X_5}$	1	1	1	1	0

k)

	X_7	X_6	X_5	X_4	X_3	X_2	X_1	X_0
XOR	1	0	1	0	1	0	1	0
	$\overline{X_7}$	X_6	$\overline{X_5}$	X_4	$\overline{X_3}$	X_2	$\overline{X_1}$	X_0
NAND	1	1	1	1	0	0	0	0
	X_7	$\overline{X_6}$	X_5	$\overline{X_4}$	1	1	1	1
NOR	0	0	0	1	1	1	1	0
	$\overline{X_7}$	X_6	$\overline{X_5}$	0	0	0	0	0

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17)

a) 1000 OR 1101 = 1101   b) 1111 AND 0101 = 0101

c) 1101 XOR 1001 = 0100   d) NOT (1111 AND 0011 = 0011) = 1100

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18)

a)

OR	X_7	X_6	X_5	X_4	X_3	X_2	X_1	X_0
	0	1	0	0	0	1	0	1
	X_7	1	X_5	X_4	X_3	1	X_1	1

b)

OR	X_7	X_6	X_5	X_4	X_3	X_2	X_1	X_0
	1	0	0	1	0	0	0	0
	1	X_6	X_5	1	X_3	X_2	X_1	X_0

c)

AND	X_7	X_6	X_5	X_4	X_3	X_2	X_1	X_0
	1	0	1	1	1	0	1	0
	X_7	0	X_5	X_4	X_3	0	X_1	0

d)

AND	X_7	X_6	X_5	X_4	X_3	X_2	X_1	X_0
	0	1	1	0	1	1	1	1
	0	X_6	X_5	0	X_3	X_2	X_1	X_0

e)

XOR	X_7	X_6	X_5	X_4	X_3	X_2	X_1	X_0
	0	1	0	0	0	1	0	1
	X_7	$\overline{X_6}$	X_5	X_4	X_3	$\overline{X_2}$	X_1	$\overline{X_0}$

f)

XOR	X_7	X_6	X_5	X_4	X_3	X_2	X_1	X_0
	1	0	0	1	0	0	0	0
	$\overline{X_7}$	X_6	X_5	$\overline{X_4}$	X_3	X_2	X_1	X_0

g)

OR	X_7	X_6	X_5	X_4	X_3	X_2	X_1	X_0
	0	0	0	0	1	0	0	0
AND	X_7	X_6	X_5	X_4	1	X_2	X_1	X_0
	1	0	1	1	1	1	1	1
XOR	X_7	0	X_5	X_4	1	X_2	X_1	X_0
	0	0	0	0	0	1	0	0
	X_7	0	X_5	X_4	1	$\overline{X_2}$	X_1	X_0

g)

AND	X_7	X_6	X_5	X_4	X_3	X_2	X_1	X_0
	0	1	1	1	0	1	1	0
XOR	0	X_6	X_5	X_4	0	X_2	X_1	0
	0	0	0	0	0	1	0	0
	0	X_6	X_5	X_4	0	$\overline{X_2}$	X_1	0

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19) 1)

$$F = \overline{(A+B)} \cdot C$$
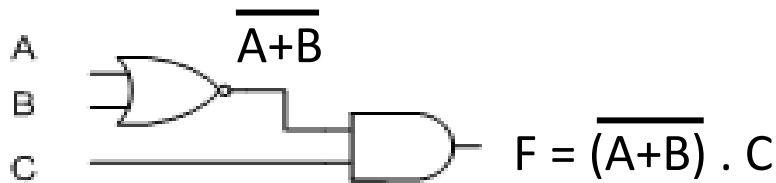
A	B	C	$\overline{A+B}$	$\overline{(A+B)}.C = F$
0	0	0	1	0
0	0	1	1	1
0	1	0	0	0
0	1	1	0	0
1	0	0	0	0
1	0	1	0	0
1	1	0	0	0
1	1	1	0	0

2)

$$F = (A.B) \oplus (C+D)$$
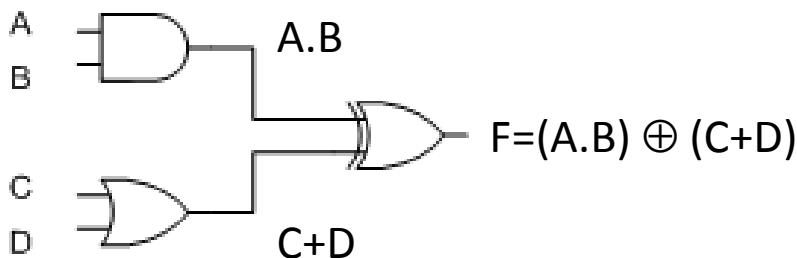
A	B	C	D	A.B	C+D	(A.B) ⊕ (C+D) = F
0	0	0	0	0	0	0
0	0	0	1	0	1	1
0	0	1	0	0	1	1
0	0	1	1	0	1	1
0	1	0	0	0	0	0
0	1	0	1	0	1	1
0	1	1	0	0	1	1
0	1	1	1	0	1	1
1	0	0	0	0	0	0
1	0	0	1	0	1	1
1	0	1	0	0	1	1
1	0	1	1	0	1	1
1	1	0	0	1	0	1
1	1	0	1	1	1	0
1	1	1	0	1	1	0
1	1	1	1	1	1	0

3)
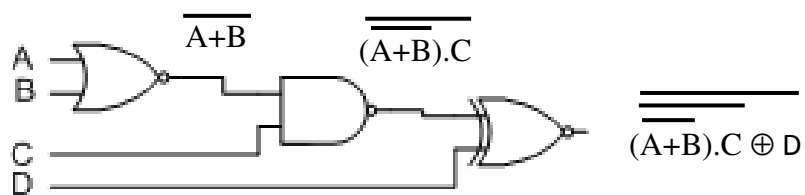
$\overline{A+B}$

$\overline{\overline{(A+B)}.C}$

$\overline{\overline{\overline{(A+B)}.C}} \oplus D$

A	B	C	D	$\overline{A+B}$	$\overline{\overline{(A+B)}.C}$	$\overline{\overline{\overline{(A+B)}.C} \oplus D}$
0	0	0	0	1	1	0
0	0	0	1	1	1	1
0	0	1	0	1	0	1
0	0	1	1	1	0	0
0	1	0	0	0	1	0
0	1	0	1	0	1	1
0	1	1	0	0	1	0
0	1	1	1	0	1	1
1	0	0	0	0	1	0
1	0	0	1	0	1	1
1	0	1	0	0	1	0
1	0	1	1	0	1	1
1	1	0	0	0	1	0
1	1	0	1	0	1	1
1	1	1	0	0	1	0
1	1	1	1	0	1	1