Positive logic System Vs Negative logic System

↳ In +ve logic system higher voltage means "logic 1" and lower voltage means "logic 0".

Difference is 5V

0V → logic 0 +5V → logic 1

+2·5V to +7·5V

↓ ↓

logic 0 logic 1

2) -2·5V to -4·5V

↓ ↓

logic 1 logic 0

↳ In -ve logic system higher voltage means "logic 0" and lower voltage means "logic 1".

For ex 0V → logic 1 +2·5V → logic 1

+5V → logic 0 +7·5V → logic 0

	High	low
negative logic	0	1
+ve logic	1	0

↳ Duality is not Complement, it changes its System (+ve to -ve logic System)

<u>Duality</u>

Dual of a function is denoted as f^d

↳ if there is a fun ($f(a,b,c) = 2, a, 1, \cdot, 0, \cdot, +$)

$f(a,b,c) = 2, 1, 0, +, \cdot$)

↳ Variable is same but opn changes

$a+b \rightarrow a \cdot b$

$a+0=a \rightarrow a \cdot 1 = a$ (both are same)

↳ We take dual of an expression to convert +ve to -ve

↳ If any expression is true, in original form then the duality will also be true.

a	b	a+b
L	L	L
L	H	H
H	L	H
H	H	H

+ve	-ve
L=0	L=1
H=1	H=0

+ve logic
~~a+~~ b system

a	b	(a+b)
0	0	0
0	1	1
1	0	1
1	1	1

-ve logic

a	b	a·b
1	1	1
1	0	0
0	1	0
0	0	0

+ve logic

$a+b \xrightarrow{\text{-ve logic}} a \cdot b$

$a+b \xrightarrow{\text{duality}} a \cdot b$

*

a	b	a·b
L	L	L
L	H	L
H	L	L
H	H	H

+ve logic System

a	b	a·b
0	0	0
0	1	0
1	0	0
1	1	1

-ve logic System

a	b	a+b
1	1	1
1	0	1
0	1	1
0	0	0

$a \cdot b$ ⟶ $a+b$

+ve logic system → -ve logic system

+ve (OR) → -ve (AND)

+ve (AND) → -ve (OR)

$a + ab = a$ (True)

$a \cdot (a+b) = a$ (True)

$f = f^c$ (They can never be same)

$\boxed{f = f^d}$ → Self dual

$a + 1 = 1$

$\cancel{a + 1 = a}$

$a = a$

$a + 0 = a$

Properties of duality

↳ property of an expression and it's duality will be same.

OR $\xleftrightarrow{\text{dual}}$ AND

NOR $\xleftrightarrow{\text{Dual}}$ NAND

EX-OR $\xleftrightarrow{\text{Dual}}$ EX-NOR

OR $\xleftrightarrow{\text{Comp}}$ NOR

AND $\xleftrightarrow{\text{Comp}}$ NAND

EX-OR $\xleftrightarrow{\text{Comp}}$ EX-NOR

$a+b \xrightarrow{\text{Comp}} \bar{a}\cdot\bar{b}$

$= \overline{a+b}$

duality

$a \cdot b$

Self dual function

A function is said to be self-dual, if func and it's dual both are same

$$f = f^d$$

Ex:- $(f^c)^c \rightarrow$ (Complement)$^{\text{Complement}}$

= Same no.

$$(f^d)^d = f$$

$$
\begin{tikzcd}
a+b \arrow[d, "\text{duality}"] \\
a \cdot b \arrow[d, "\text{duality}"] \\
a+b \arrow[uu, bend right, leftrightarrow]
\end{tikzcd}
$$

i) $f = f^d$ (Self dual)

Ex:

$f(a,b) = \Sigma(0,2) = \bar{a}\bar{b} + a\bar{b}$

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

$\bar{b}[\bar{a} + a]$

$= \bar{b}$

$\downarrow$ duality

$\bar{b}$

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

$= \cancel{\bar{a}\cdot a}^{\,0} + \bar{a}\bar{b} + \bar{b}a + \bar{b}\cdot\bar{b}$

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

$= \bar{a}\bar{b} + \bar{b}[\cancel{1+a}]$

$= \bar{b}[1+\bar{a}] = \bar{b}$

	$\bar{a}$	a
$\bar{b}$	1	1
b		

$= \bar{b}$

$$f(a, b, c) = \bar{a}\bar{b} + a\bar{b} + ab$$