Ex:- List the truth table of the function, and then implement it using NAND gate only:-

$F = AB + BC + \bar{A}\bar{B}C$

Solution:- $F = AB + BC + \bar{A}\bar{B}C$

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

$F = \underline{ABC} + ABC\bar{} + \underline{ABC} + \bar{A}BC + \bar{A}\bar{B}C$

$F = \underbrace{\overset{111}{ABC}}_{7} + \underbrace{\overset{110}{AB\bar{C}}}_{6} + \underbrace{\overset{011}{\bar{A}BC}}_{3} + \underbrace{\overset{001}{\bar{A}\bar{B}C}}_{1}$

$F = \sum 1, 3, 6, 7$

ABC	F
000	0
001	1
010	0
011	1
100	0
101	0
110	1
111	1

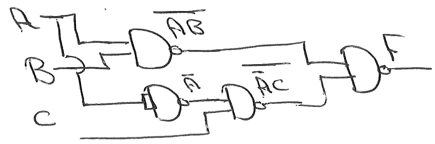
$F = ABC + AB\bar{C} + \bar{A}BC + \bar{A}\bar{B}C$

$F = AB\underbrace{[C+\bar{C}]}_{1} + \bar{A}C\underbrace{[B+\bar{B}]}_{1}$

$F = AB + \bar{A}C$

$F = \overline{\overline{AB + \bar{A}C}}$

$F = \overline{\overline{AB} \cdot \overline{\bar{A}C}}$



(H.W): Develop a truth table for the following SOP expression:-

$F = \bar{X} + Y\bar{Z} + WZ + X\bar{Y}Z$

(H.W): Convert the following expressions to standard SOP forms:-

a) $AB(\bar{B}\bar{C} + BD)$ b) $A + B[AC + (B+\bar{C})D]$

2- The product of Sums (POS):-

POS is a term consisting of the sum (Boolean adding) of literal (variables) or their complements, when two or more sum are multiplied. A product of sum is also known as a **maxterm expression**. It can be obtained from the truth table by considering these input combinations that produce a logic 0 at the output.

Ex:- $F = (\bar{A}+B)(A+\bar{B}+C) \longrightarrow POS$.

Ex:- Convert the following Boolean expression to standard POS form:-

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

Note:- In POS to convert it to standard POS form we ORed it misses one or more variables with an expression such as $(X\bar{X})$, where is one of the missing variables

Solution:- $F = (A+\bar{B}+C+D\bar{D})(\bar{B}+C+\bar{D}+A\bar{A})(A+\bar{B}+\bar{C}+D)$

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

Ex:- Represent F in POS form then simplify using theorem and implement it:-

	A	B	C	F	
M_0	0	0	0	0	$A+B+C$
M_1	0	0	1	1	
M_2	0	1	0	1	
M_3	0	1	1	1	
M_4	1	0	0	0	$\bar{A}+B+C$
M_5	1	0	1	1	
M_6	1	1	0	1	
M_7	1	1	1	1	

$\left.\begin{matrix} 0 \longrightarrow X \\ 1 \longrightarrow \bar{X} \end{matrix}\right]$ in POS

$F = \prod M_0, M_4$

$F = \prod 0, 4$

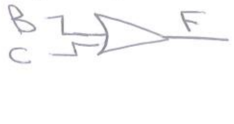
$F = (A+B+C)(\bar{A}+B+C)$

$F = \underbrace{A\bar{A}}_{0} + AB + AC + \bar{A}B + \underbrace{BB}_{B} + BC + \bar{A}C + BC + \underbrace{CC}_{C}$

$F = \underline{AB} + AC + \underline{\bar{A}B} + \underline{B} + \bar{A}C + \underline{BC} + C$

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

$F = B+C$



Note:- The complement of standard SOP minterms equals the sum of minterms missing from the original function which are equal the standard POS maxterms.

$$\text{POS maxterm} = \overline{\text{SOP minterm}}$$

$$\text{SOP minterm} = \overline{\text{POS maxterm}}$$

Ex:- $F = \sum(1,4,5,6,7)$

$\bar{F} = \sum 0,2,3 = \prod 0,2,3$

Ex:- $F = \prod(0,2,4,5)$

$\bar{F} = \sum(1,3,6,7)$

Ex:- Convert the following SOP expression to an equivalent POS expression:-

a) $F = \overset{000}{\bar{A}\bar{B}\bar{C}} + \overset{010}{\bar{A}B\bar{C}} + \overset{011}{\bar{A}BC} + \overset{101}{A\bar{B}C} + \overset{111}{ABC}$

$F = \sum 0,2,3,5,7$

$F = \prod 1,4,6$

$F = (A+B+C')(A'+B+C)(A'+B'+C)$

b) $F = w\bar{x}y + \bar{x}y\bar{z} + wx\bar{y}$

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

$$F = \underset{\substack{1011\\11}}{w\bar{x}yz} + \underset{\substack{1010\\10}}{w\bar{x}y\bar{z}} + \underset{\substack{1010\\10}}{w\bar{x}y\bar{z}} + \underset{\substack{0010\\2}}{\bar{w}\bar{x}y\bar{z}} + \underset{\substack{1101\\13}}{wx\bar{y}z} + \underset{\substack{1100\\12}}{wx\bar{y}\bar{z}}$$

$F = \sum 2,10,11,12,13$

$F = \prod 1,3,4,5,6,7,8,9,14,15,0$

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