9. i) Literal :- A literal is a variable available either in normal or complement form.

e.g. Literals in Boolean Expression :

$$A'B(D+CD')+B(A+A'CD)$$

Sol. No. of literals = 10.

ii) fundamental Product (Minterm) :- The Product of all literals either with complement or without complement.

e.g. 1. xz', $x'y.z$, $xy'z$ are fundamental Products

2. $xyx'z$ and $xyzy$ are not fundamental Products.

3. Reduce to fundamental Product i) $xyx'z$

$\Rightarrow (xx')yz \quad (\because a \cdot a' = 0)$

$\Rightarrow (0)yz \Rightarrow 0$

ii) $xyzy = xz(yy) \Rightarrow xz(y) \Rightarrow xyz$.

iii) $xy'zxy' = zzx(y'y') \quad (\because a \cdot a = a)$

$= (xx)z(y')$

$\Rightarrow xy'z$

iii) Maxterm :- maxterm of n variable is a sum of n variables in which each variable appears exactly once in either true or complemented form but not both

e.g. $x+y$, $x'+y$, $x+y'$, $x'+y'$, etc.

$x'+y+z'$, $x'+y'+z$

iv). Sum of Product (Disjunctive normal form or DNF) (SOP) :-

A Boolean Expression E is called SOP if E is a fundamental product or the sum of two or more fundamental products none of which is contained in another.

e.g 1. $E(x,y,z) = xz' + y'z + xyz'$

it is not SOP $\because$ xz' contain in xyz'

$$E(x,y,z) = (xz' + xyz') + y'z$$
$$= xz'(1+y) + y'z$$
$$= xz'(1) + y'z$$
$$= xz' + y'z \rightarrow \text{which is S.O.P}$$

or

A boolean Expression over two value Boolean algebra is said disjunctive normal form (SOP) if it is join of minterms.

e.g 2. $f(x,y,z) = (x' \wedge z) \vee (y \wedge z) \vee (y \wedge z')$

simply and write in Minterm Normal form.

Sol. $f(x,y,z) = (x' \wedge z) \vee [y \wedge (z \vee z')]$
$$= (x' \wedge z) \vee (y \wedge 1)$$
$$= (x' \wedge z) \vee y$$

x	y	z	x'	$x' \wedge z$	$(x' \wedge z) \vee y$	mint.
0	0	0	1	0	0	m_1
0	0	1	1	1	1	m_2
0	1	0	1	0	1	m_3
0	1	1	1	1	1	m_4
1	0	0	0	0	0	m_5
1	0	1	0	0	0	m_6
1	1	0	0	0	1	m_7
1	1	1	0	0	1	m_8

minterm are $m_2 = x' \wedge y' \wedge z$

$m_3 = x' \wedge y \wedge z'$

$m_4 = x' \wedge y \wedge z$

$m_7 = x \wedge y \wedge z'$, $m_8 = x \wedge y \wedge z$

Hence minterm Normal form = $m_2 \vee m_3 \vee m_4 \vee m_7 \vee m_8$

$\Rightarrow (x' \wedge y' \wedge z) \vee (x' \wedge y \wedge z') \vee (x' \wedge y \wedge z) \vee (x \wedge y \wedge z') \vee (x \wedge y \wedge z)$.

Complete Sum of Product :- A Boolean Expression E is said to Complete S.O.P if E is a sum of Product Expression where each Product involves all the n-variables.

A fundamental Product which involves all the variables is called minterm.

Q.3 · Express E as SOP and Complete SOP.

i) $E = x(xy' + x'y + y'z)$

ii) $E = z(x'+y) + y')$

i) $E = x(xy' + x'y + y'z)$

$= xxy' + xx'y + xy'z$

$= xy' + 0 \cdot y + xy'z$ $[a \cdot a' = 0,\ a \cdot a = a]$

$= xy' + xy'z$

$= xy'$ [$\because$ xy' contain in $xy'z$]

S.O.P

ii) $E = xy'(z'+z) \Rightarrow xy'z' + xy'z$

which is Complete S.O.P.

ii) $E = z(x'+y) + y'$

$= zx' + zy + y'$ which is S.O.P.

$E = x'z(y+y') + yz(x+x') + y'(x+x')(z+z')$

$= x'zy + x'zy' + yzx + yzx' + y'[xz + xz' + x'z + x'z']$

$= x'zy + x'zy' + yzx + yzx' + y'xz + y'xz' + y'x'z + y'x'z'$

$= x'yz + x'y'z + xyz + x'yz + xy'z + xy'z' + x'y'z + x'y'z'$

$= xyz + (x'yz + x'yz) + (x'y'z + x'y'z) + xy'z' + xy'z + x'y'z'$

$E = xyz + x'yz + x'y'z + x'yz' + xy'z + x'y'z'$

which is Complete S.O.P.

<u>Q.4</u> Express $E = (x'+y)' + x'y$ in Comple S.O.P.

<u>Sol.</u> $E = (x'+y)' + x'y$

$= (x')'y' + x'y \quad ((a+b)' = a'b')$

$= xy' + x'y$

$= xy'(z+z') + x'y(z+z')$

$= xy'z + xy'z' + x'yz + x'yz'$

which is Complete <u>S.O.P</u> of E.

<u>Q5</u> Express $E = x'y'z + xyz + y + yz' + x'z$

in Complete S.O.P

<u>Sol</u> $E = x'y'z + xyz + y(x+x')(z+z') + yz'(x+x') + x'z(y+y')$

$= x'y'z + xyz + y[xz + xz' + x'z + x'z'] + yz'x + yz'x' + x'zy + x'zy'$

$= (x'y'z + x'y'z) + (xyz + xyz) + (yxz' + yxz') + (yx'z + x'zy) + (yx'z' + yx'z')$

$= x'y'z + xyz + xyz' + x'yz + x'yz'$

which is Complete <u>S.O.P.</u>