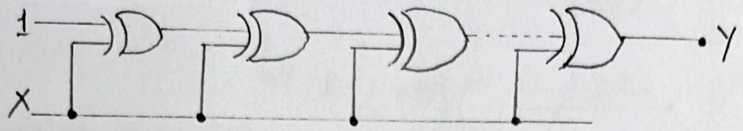
Q) 1) If the input to the digital circuit of the below figure consisting of a cascade of 20 XOR gates is X, then what is the out put Y?



Ans → The truth table for an XOR Gate →

X	Y	O
0	0	0
0	1	1
1	0	1
1	1	0

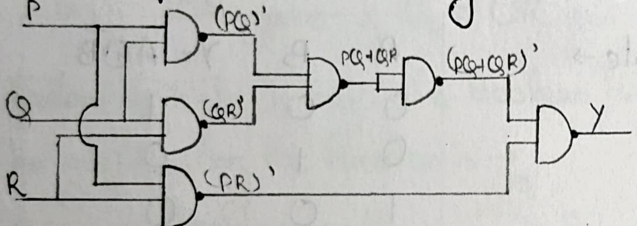
When one of the input to an XOR gate in 1, the out put is simply the inverted value of the other input.

Output of 1st XOR gate will be → $1 \oplus X = \overline{X}$

Then, 2nd output → $\overline{X} \oplus X = 1$

∴ For 20 such gates, the out put of Y will be 1.

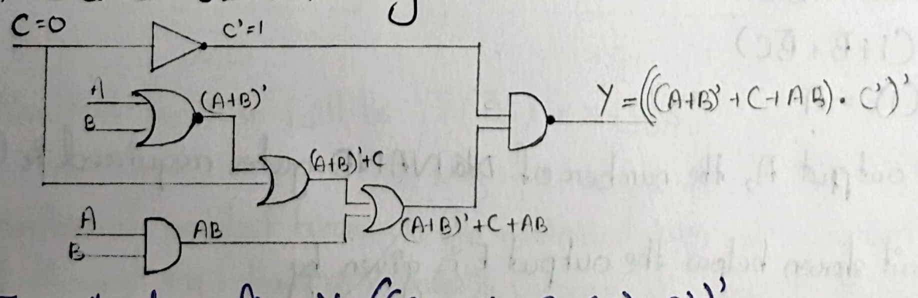
Q) 2) The output Y in the following circuit shown below is always 1 when



Ans → Here, the output $Y = PQ + QR + PR$ as we can see from above diagram

If 2 or more inputs are 1, then only it will be 1.

Q) 3) In the circuit shown in the fig., if C = 0, the expression for Y is



Ans → From the above fig, $Y = ((A+B)' + C + AB) \cdot C')'$

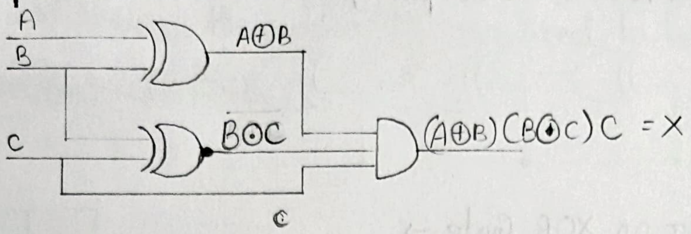
$= ((A+B)' + AB)'$ (As $C = 0$ & $C' = 1$)

$= (\bar{A}\bar{B} + AB)'$

$= \overline{A \odot B}$

$= A \oplus B$

Q4) For the logic circuit shown in the fig., the required input condition (A, B, C) to make the output (X) = 1 is

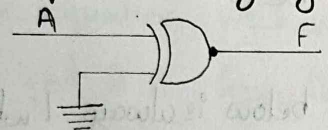


Ans → For, $X=1$,

$A \oplus B = 1$, i.e. $A=0$, $B=1$

$B \odot C = 1$; i.e $B=1$, $C=1$

Q5) The output of the logic gate in fig. is



Ans → Truth table for XNOR Gate →

A	B	$Y=\overline{A\oplus B}$
0	0	1
0	1	0
1	0	0
1	1	1

Output equation → $Y=\overline{A\oplus B}$

As B is low, $Y=\overline{A\oplus 0}=\overline{A}$.

Q6) The minimum number of NAND gates required to implement the Boolean function $A+A\bar{B}+A\bar{B}C$ is equal to ___.

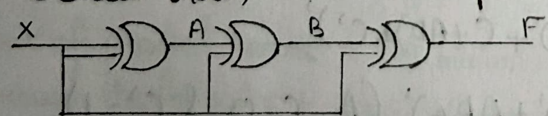
Ans → $F = A + A\bar{B} + A\bar{B}C$

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

$= A(1) = A$

∴ To get output A, the number of ~~Na~~ NAND gates required is 0.

Q7) For the circuit shown below the output F is given by



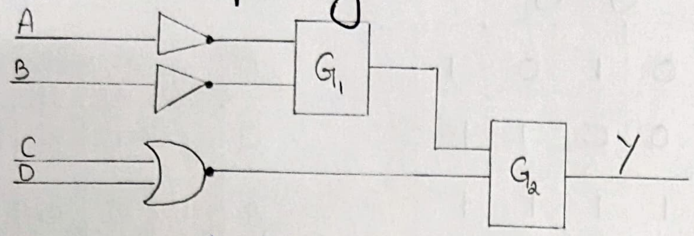
Ans → $A = X \oplus X = 0$

$B = A \oplus X = 0 \oplus X = X$

$F = X \oplus X = 0$

$\therefore F = 0$

Q)8) In the figure shown, the output Y is required to be $Y = A \cdot B + \overline{C} \cdot \overline{D}$. The gates G_1 & G_2 must be respectively.



Ans → The NOR gate takes the input C & D will give the output as $\overline{C+D}$ or $\overline{C} \cdot \overline{D}$.

$\therefore F = A \cdot B + \overline{C} \cdot \overline{D}$

From the equation, we have $\overline{C} \cdot \overline{D}$., So, the G_2 will be OR gate.

Next to get A.B, from the fig. $\overline{A}$ & $\overline{B}$ has to ~~pas~~ pass through the NOR gate.

$\therefore G_1$ = NOR gate & G_2 = OR gate.

Q)9) Following is the K-map of a Boolean function of five variables P, Q, R, S & X. The minimum for the function is →

X = 0

RS \ PQ	00	01	11	10
00	0	0	0	0
01	1	0	0	1
11	1	0	0	1
10	0	0	0	0

X = 1

RS \ PQ	00	01	11	10
00	0	1	1	0
01	0	0	0	0
11	0	0	0	0
10	0	1	1	0

Ans → Resultant function will be $\overline{X}(\overline{Q}S) + X(Q\overline{S})$

$= x'q's + x'qs'$

10) The number of product terms in the minimised sum-of-product expression obtained through the following K-map is (where 'd' denotes don't care states).

1	0	0	1
0	d	0	0
0	0	d	1
1			1

Ans → So, from the fig., we get that there will be 2 SOP.

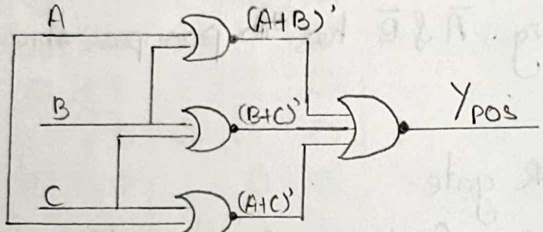
11) The truth table for the output Y in the terms of three inputs A, B & C are given in Table. Draw a logic circuit realisation using only NOR gates.

	0	1	2	3	4	5	6	7
A	0	1	0	1	0	1	0	1
B	0	0	1	1	0	0	1	1
C	0	0	0	0	1	1	1	1
Y	1	1	1	0	1	0	0	0

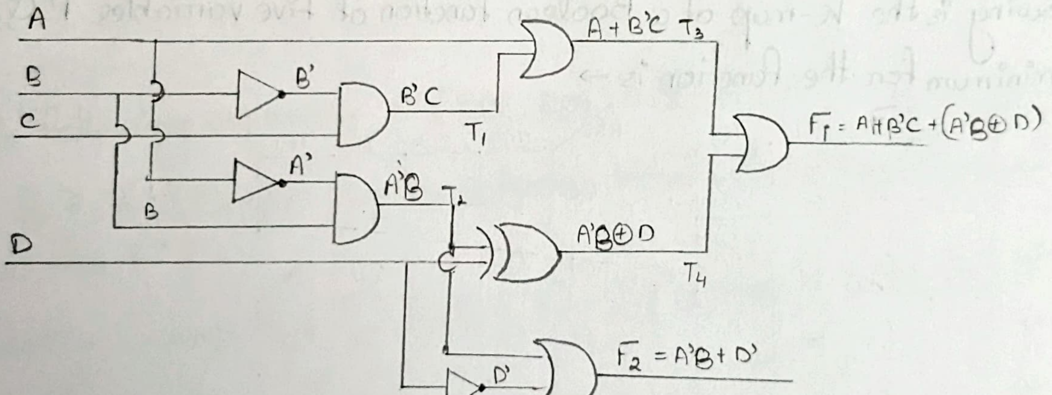
C \ BA	00	01	11	10
0	1	1	0	1
1	1	0	0	0

Ans → From the k-map, we got $Y_{POS} = (C+B)(A+B)(A+C)$

$Y_{SOP} = (A'B') + (A'C') + (B'C')$



12)



Consider the combinational circuit shown above →

a) Derive the Boolean expressions for T_1 through T_4. Evaluate the outputs F_1 & F_2 as a function of 4 inputs.

b) List the truth table with 16 binary combinations of the four input variables. Then list the binary values for T_1 through T_4 and outputs F_1 & F_2 in the table.

Ans → a) $T_1 = B'C$, $T_2 = A'B$, $T_3 = A + B'C$, $T_4 = A'B \oplus D = A'BD' + (A'B)'D$

$= A'BD' + (A+B')D$

$= A'BD' + AD + B'D$

$F_1 = T_3 + T_4 = A + B'C + A'BD' + B'D + AD$

$= A(1+D) + A'BD' + B'C + B'D$

$= (A+A')(A+BD') + B'C + B'D$

$= A + BD' + B'C + B'D$

$F_2 = A'B + D'$

b) Truth Table →

Inputs				Outputs					
A	B	C	D	T_1	T_2	T_3	T_4	F_1	F_2
0	0	0	0	0	0	0	0	0	1
0	0	0	1	0	0	0	1	1	0
0	0	1	0	1	0	1	0	1	1
0	0	1	1	1	0	1	1	1	0
0	1	0	0	0	1	0	1	1	1
0	1	0	1	0	1	0	0	0	1
0	1	1	0	0	1	0	1	1	1
0	1	1	1	0	1	0	0	0	1
1	0	0	0	0	0	1	0	1	1
1	0	0	1	0	0	1	1	1	0
1	0	1	0	1	0	1	0	1	1
1	0	1	1	1	0	1	1	1	0
1	1	0	0	0	0	1	0	1	1
1	1	0	1	0	0	1	1	1	0
1	1	1	0	0	0	1	0	1	1
1	1	1	1	0	0	1	1	1	0

13) Consider the following expression $F(P,Q,R,S) = \Sigma(0,2,5,7,8,10,13,15)$. The minterms 2, 7, 8 & 13 are don't-care terms. What is the minimal sum-of-products form for F?

Ans → Plotting k-map for $F(P,Q,R,S) = \Sigma(0,2,5,7,8,10,13,15)$

PQ \ RS	00	01	11	10
00	1			X
01		1	X	
11		X	1	
10	X			1

From the k-map,

$$F_{SOP} = QS + \bar{Q}\bar{S}$$
$$= Q \odot S$$
$$= \overline{Q \oplus S}$$

14) Let the minterm expression $F(A,B,C,D) = \Sigma_m(0,2,4,6,8) + \Sigma_d(1,3,10)$. What is the minimal form of the function represented by the Karnaugh map?

Ans → Plotting the k-map for $F(A,B,C,D) = \Sigma_m(0,2,4,6,8) + \Sigma_d(1,3,10)$

AB \ CD	00	01	11	10
00	1	X	X	1
01	1			1
11				
10	1			X

From the k-map,

$$F_{SOP} = B'D' + A'D'$$
$$= \cancel{A'(} \; D'(A'+B')$$

15) What is the minimum SOP for $F(w,x,y,z) = \Sigma m(4,6,9,11,12,14) + \Sigma_d(1,3,10)$?

Ans → Plotting the k-map for $F(w,x,y,z) = \Sigma_m(4,6,9,11,12,14) + \Sigma_d(1,3,10)$

wx \ yz	00	01	11	10
00		X	X	
01	1			1
11	1			1
10		1	1	X

From the k-map,

$$F_{SOP} = xz' + x'z$$
$$= x \oplus z$$

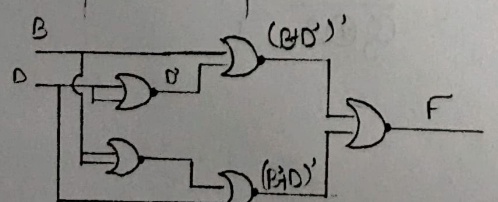
16) Implement the 4-variable function using minimum number of 2-input NOR gates, which is expressed in sum-of-minterms form as $F = \Sigma(0,2,5,7,8,10,13,15)$.

Ans → Plotting the k-map for $F(A,B,C,D) = \Sigma(0,2,5,7,8,10,13,15)$

AB \ CD	00	01	11	10
00	1			1
01		1	1	
11		1	1	
10	1			1

From the k-map,

$$F_{SOP} = BD + B'D'$$
$$= \overline{B \oplus D}$$
$$= \cancel{(B'D)(} (B'D + BD')'$$
$$= (B+D')(B'+D)$$



17) What is the minimum POS for $F(A,B,C,D) = \Sigma m(1,3,4,6,9,11,12,14)$?

Ans → Plotting the k-map for $F(A,B,C,D) = \Sigma m(1,3,4,6,9,11,12,14)$

AB \ CD	00	01	11	10
00		1	1	
01	1			1
11	1			1
10		1	1	

$F_{SOP} = B'D + BD'$

For $F_{POS} = (F_{SOP})'$

$= (B'D + BD')'$

$= (B + D')(B' + D)$

$= (B + D)(B' + D')$

18) Consider the minterms list form of a Boolean function $F(P,Q,R,S) = \Sigma m(0,2,5,7,9,11) + \Sigma d(3,8,10,12,14)$. Here, m denote a minterm & d denotes a don't care term, then what are the essential prime implicants of the function F?

Ans → Plotting the k-map for $F(P,Q,R,S) = \Sigma m(0,2,5,7,9,11) + \Sigma_d(3,8,10,12,14)$

PQ \ RS	00	01	11	10
00	1		X	1
01		1	1	
11	X			X
10	X	1	X	1

From the k-map,

$F_{SOP} = P'QS + PQ' + Q'S'$

∴ There are 3 essential prime implicants.