K -Maps -I

Comprehensive Course on Digital Logic Design 2023/2024

B V Reddy • Lesson 15 • Nov 8, 2022

Q.1

Minimized expression of

$$F = \left[\overline{\overline{\overline{AB}.C}.D}\right] + B$$

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

$$F = \left(\overline{\overline{\overline{AB}\,C}} + \overline{D}\right) + B$$

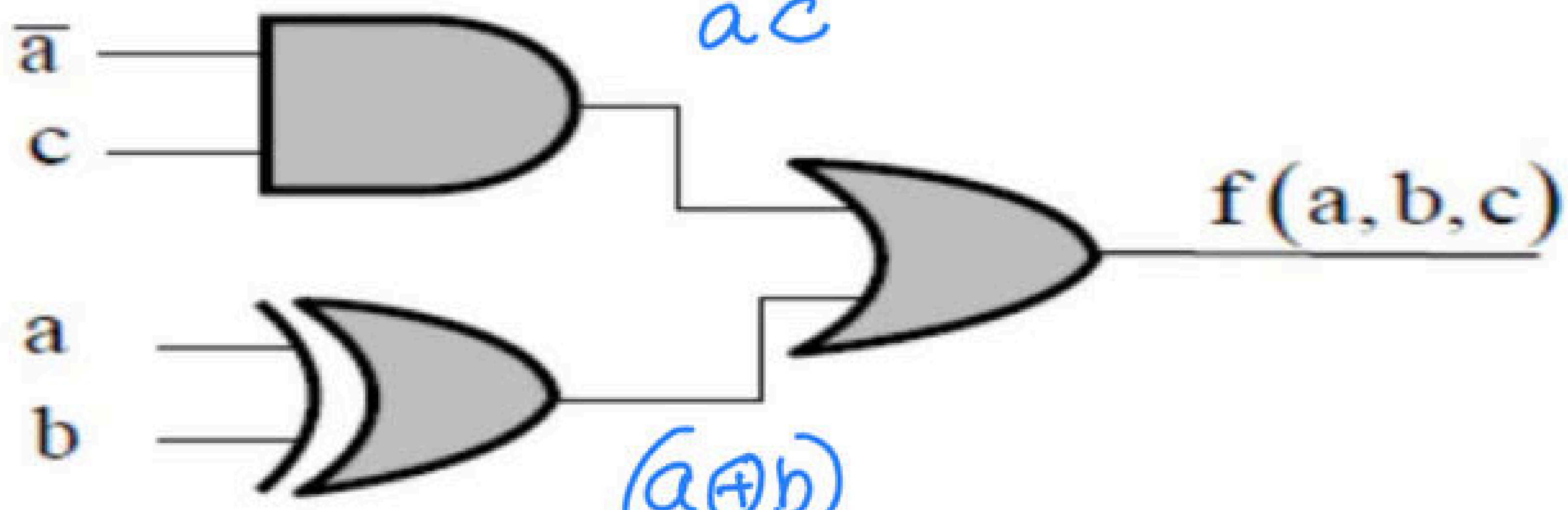
$$F = \left(\overline{AB}\,C + \overline{D}\right) + B$$

$$F = \left[(\overline{A} + \overline{B})C + \overline{D}\right] + B$$

$$F = \left(\overline{A}C + \overline{B}C + \overline{D}\right) + B = \overline{A}C + \overline{D} + B + C$$

$$= C + \overline{D} + B$$

Q .2 For the logic circuit shown below expression of f(a,b,c) is



$\bar{a}c$

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

$(a \oplus b)$

a) $ac+(a \oplus b)$

b) $\overline{ac+a \odot b}$

c) $\bar{a}c+a \oplus b$

d) $ab+(a \oplus c)$

Q .3

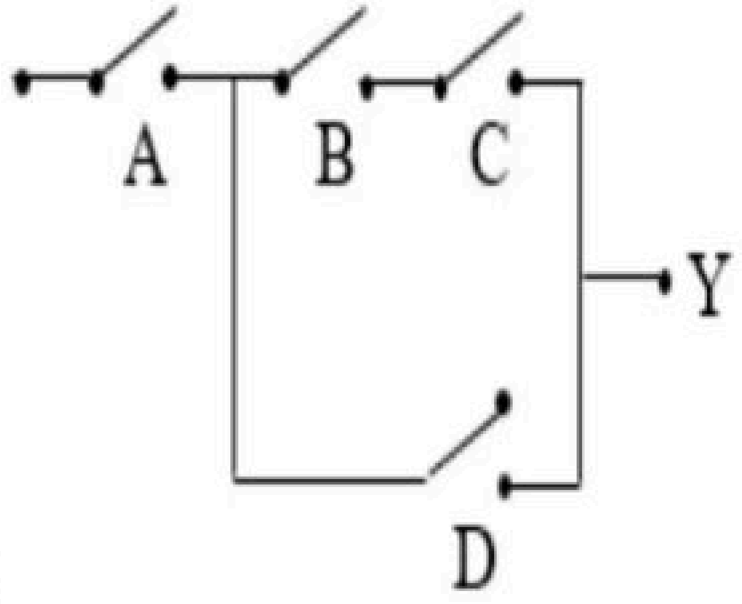
For the switch circuit, tasking open as 0 and closed as 1, the expression for 'y' in the circuit is

(a) $A+(B+C)D$

(b) $A + BC + D$

(c) ~~$A(BC+D)$~~

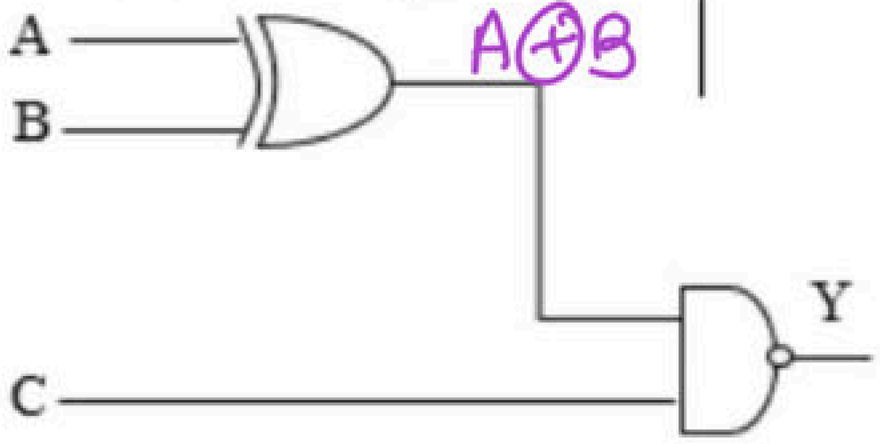
(d) None of these



$A[BC+D]$

Q .4

The Boolean expression for the output of the logic circuit shown in the figure is



$$= \overline{(A\oplus B)C} = A\odot B + \overline{C}$$

$$= \overline{A}\,\overline{B} + AB + \overline{C}$$

(a) $Y = AB + \overline{A}\,\overline{B} + C$

(b) $Y = \overline{A}\,\overline{B} + AB + \overline{C}$

(c) $Y = A\overline{B} + \overline{A}B + C$

(d) $Y = AB + \overline{A}B + \overline{C}$

Q.5

. For the Truth table given in Fig, The minimized Boolean Expression is.

$P = \Sigma m(0, 3, 5, 6)$

$p = x \odot y \odot z$

$p = \bar{x}\bar{y}\bar{z} + \bar{x}yz + x\bar{y}z + xy\bar{z}$

Input			Output
X	Y	Z	P
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	0

$y \oplus z = A$

(a) $P = XYZ + \bar{X}Y\bar{Z} + X\bar{Y}\bar{Z} + \bar{X}\bar{Y}Z$

(b) $P = \overline{X \oplus Y \oplus Z}$

(c) $P = \bar{X}(\overline{Y \oplus Z}) + X(Y \oplus Z)$ $= \bar{x}\bar{A} + xA = A \odot x = (y \oplus z) \odot x$

(d) $P = X \oplus \bar{Y} \oplus Z$

$$f = (\underbrace{y \oplus z}_{A}) \odot x.$$

$$y \oplus z = A.$$

$$f = \bar{A}\bar{x} + Ax.$$

$$f = (y \odot z)\bar{x} + (y \oplus z)x.$$

$$f = (\bar{y}\bar{z} + yz)\bar{x} + (\bar{y}z + y\bar{z})x.$$

$$f = \underset{0}{\bar{x}\bar{y}\bar{z}} + \underset{3}{\bar{x}yz} + \underset{5}{x\bar{y}z} + \underset{6}{xy\bar{z}}.$$

$$P = x \oplus \bar{y} \oplus z$$

$$P = \bar{x}\bar{\bar{y}}z + \bar{x}\bar{y}\bar{z} + x\bar{\bar{y}}\bar{z} + x\bar{y}z.$$

$$P = \underset{3}{\bar{x}yz} + \underset{0}{\bar{x}\bar{y}\bar{z}} + \underset{6}{xy\bar{z}} + \underset{5}{x\bar{y}z}.$$

$$P = \Sigma m\,(0, 3, 5, 6)$$

Q .6

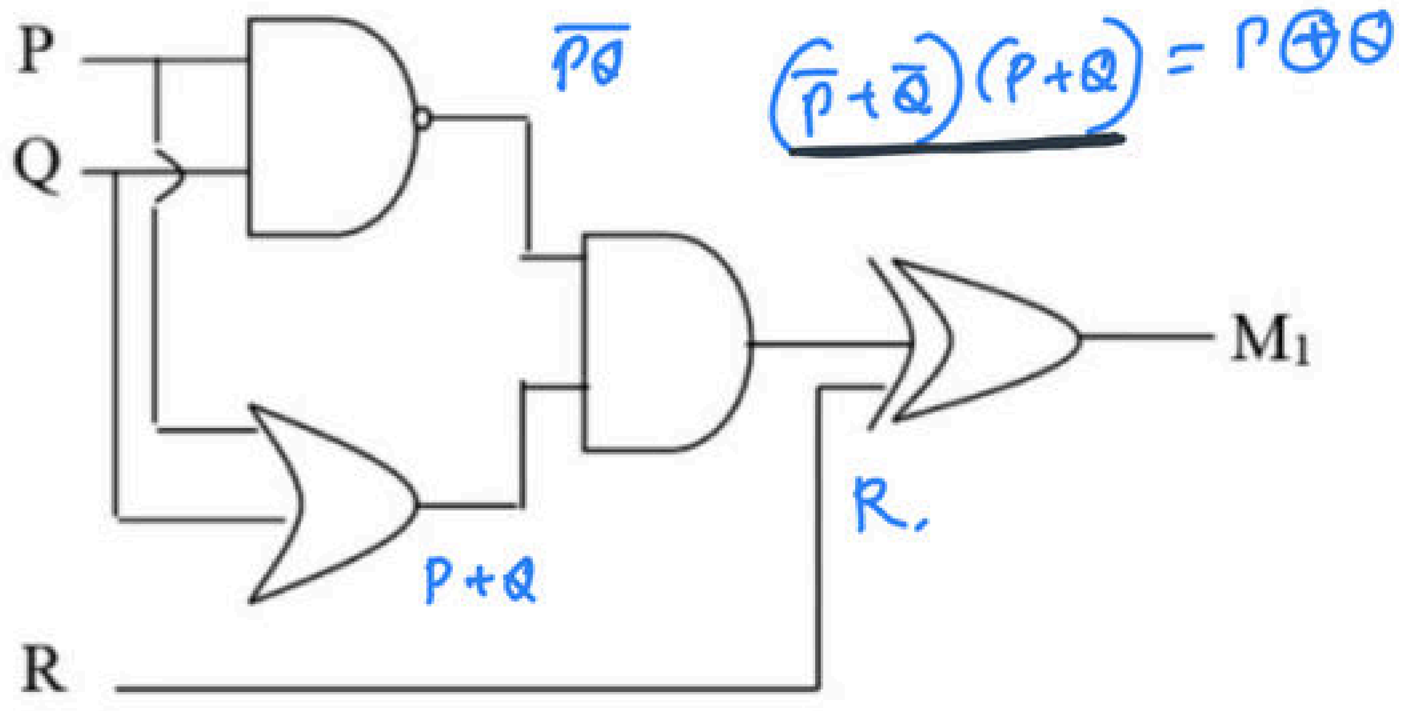
Which of the following Boolean expressions correctly represents the relation between P, Q, R and M_1?

(a) M_1=(P OR Q) XOR R

(b) M_1=(P AND Q) XOR R

(c) M_1=(P NOR Q) XOR R

(d) M_1=(P XOR Q) XOR R



$$M_1 = [P \oplus Q] \oplus R$$

$$\boxed{M_1 = P \oplus Q \oplus R}$$

Q .7

If $F(A, B, C) = AB + AC + BC$, then $F(\overline{A}, \overline{B}, C).F(\overline{A}, B, \overline{C}).F(A, \overline{B}, \overline{C}) = ?$

(a) $\overline{A}\,\overline{B}\,\overline{C}$

(b) $\overline{A} \oplus \overline{B} \oplus \overline{C}$

(c) $\overline{A} \oplus \overline{B} \odot \overline{C}$

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

$\overline{A}\,\overline{B}\,\overline{C}$

$$f(A, B, C) = AB + BC + AC.$$

$$f(\bar{A}, \bar{B}, C) = \bar{A}\bar{B} + \bar{B}C + \bar{A}C = \Sigma m(0, 1, 3, 5)$$

000	001	001
001	101	011

$$f(\bar{A}, B, \bar{C}) = \bar{A}B + B\bar{C} + \bar{A}\bar{C} = \Sigma m(0, 2, 3, 6)$$

010	010	000
011	110	010

$$f(A, \bar{B}, \bar{C}) = A\bar{B} + \bar{B}\bar{C} + A\bar{C} = \Sigma m(0, 4, 5, 6)$$

100	000	100
101	100	110

$C\overline{A} = \overline{A}C$

Q .8

The value of f (A, B, C) = $A\overline{B} + B\overline{C} + C\overline{A}$ is also equal to

~~(A)~~ $\overline{A}B + \overline{B}C + \overline{C}A$ (B) $\overline{A}\ \overline{B} + \overline{B}\ \overline{C} + \overline{C}\ \overline{A}$ (C) AB+BC+CA (D) None

$f(A,B,C) = A\overline{B} + B\overline{C} + \overline{A}C = \Sigma m(1,2,3,4,5,6)$

100 010 001

101 110 011

a) $\overline{A}B + \overline{B}C + A\overline{C} = \Sigma m(1,2,3,4,5,6)$

010 001 100

011 101 110

Q .9

What is the max term expansion of f = $A + B\overline{C} + AB\overline{D} + ABCD$

(A) $f = \prod M(4,5,8,9,10,11,12,13,14,15)$ ~~(B)~~ $f = \prod M(0,1,2,3,6,7)$

(C) $f = \prod M(0,1,2,3,6,7,8,9,10,11)$ (D) $f = \prod M(3,4,5,6,7,8,9,10,11,12,13)$

$f = A + B\overline{C}$

8	1000	0100	4
9	1001	0101	5
10	1010	1100	12
11	1011	1101	13
12	1100		
13	1101		
14	1110		
15	1111		

$f = \sum m(4,5,8,9,10,11,12,13,14,15)$

$f = \pi M(0,1,2,3,6,7)$

Q.10

Given $\overline{AB}+\overline{A}B=C$, then find $\overline{AC}+\overline{A}C=?$

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

$\overline{A}+\overline{B}+\overline{A}B=C$

$\overline{A}+\overline{B}=C$

$\overline{AB}=C$

$\overline{C}=AB$

$\overline{A}+\overline{C}+\overline{A}C=\overline{A}+\overline{C}$

$=\overline{A}+AB$

$=\overline{A}+B$

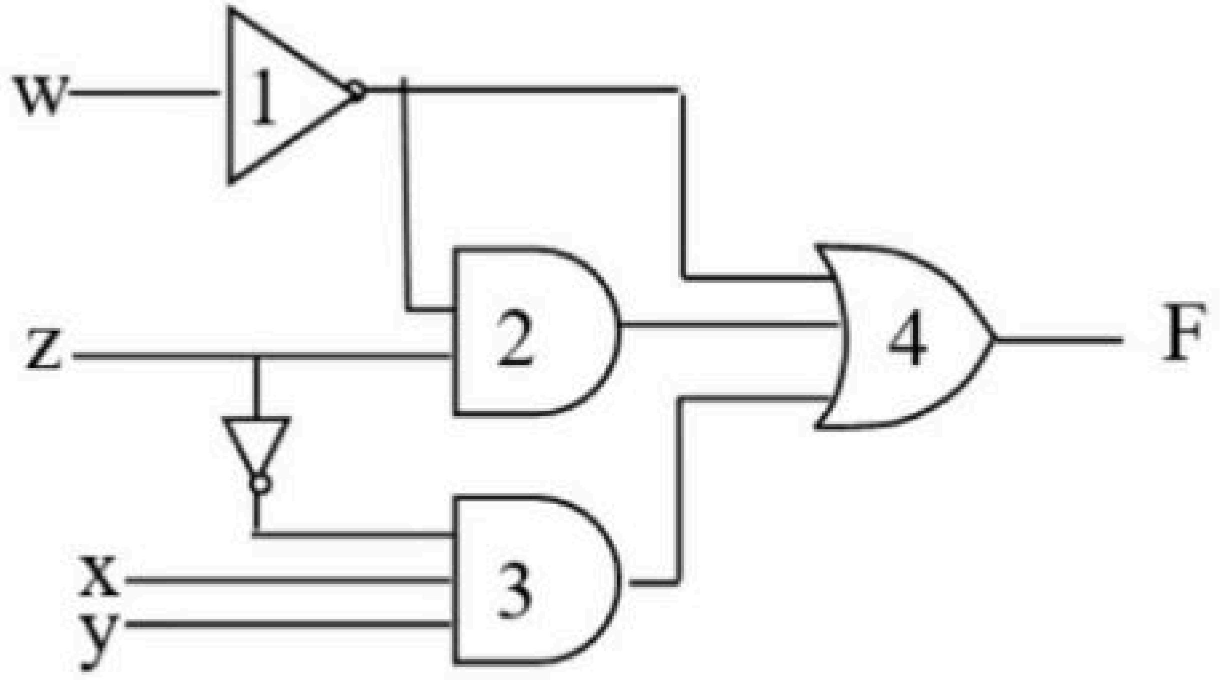
Q.11

What is the simplified Boolean expression for F = $\overline{A} + AB + AB\overline{D} + A\overline{B}\ \overline{D} + C$

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

Q.12

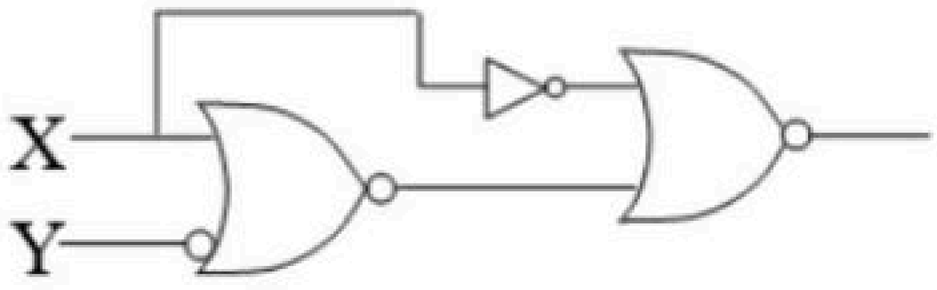
Which gate is redundant in the following circuit?



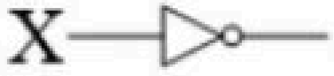
(A) 1 (B) 2 (C) 3 (D) 4

Q.13

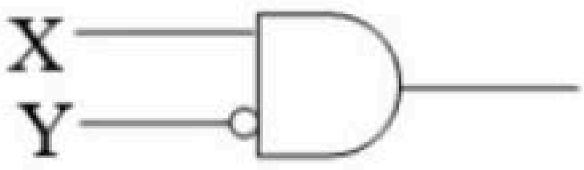
The logic circuit shown below is equivalent to



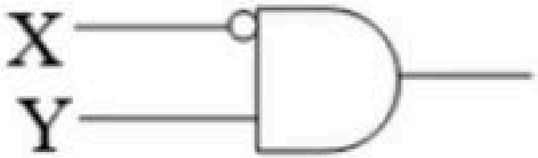
(a)



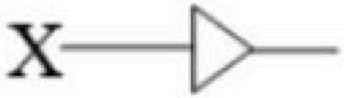
(b)



(c)

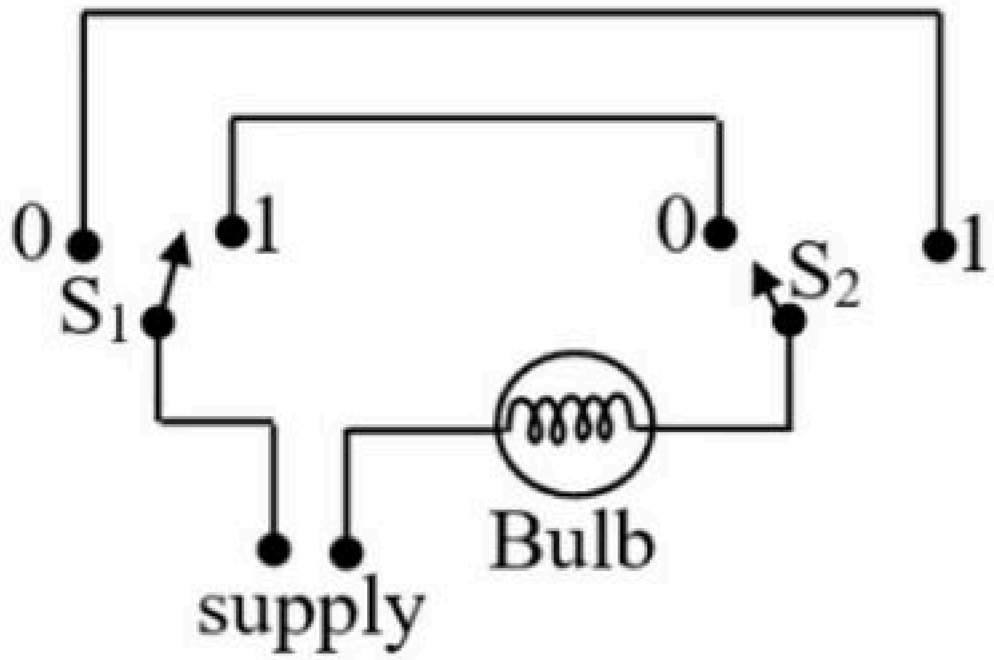


(d)



Q.14

Identify the following logic gate

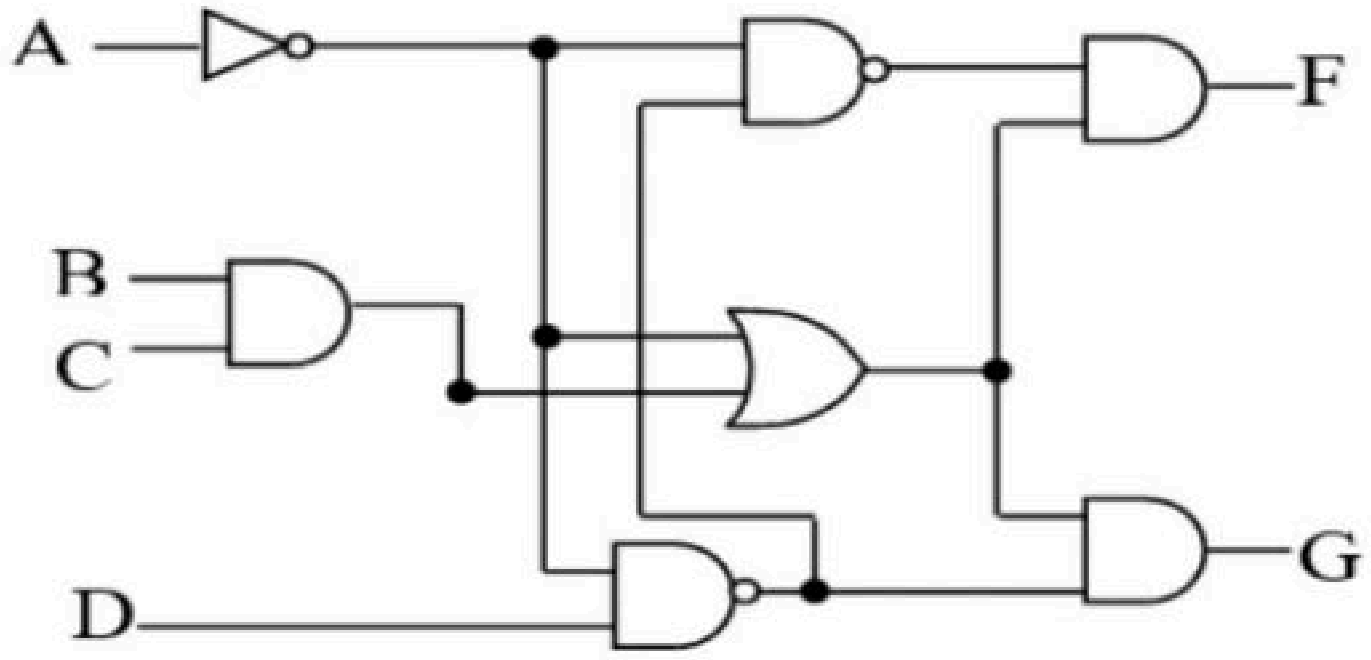


(a) AND (b) NOR

(c) EX-OR (d) EX-NOR

Q.15

The simplified Boolean expression for output F in terms of the input variables in the circuit given below is



(a) $\overline{A}D + A\overline{B}C$ (b) $\overline{A}D + ABC$

(c) $\overline{A}B + ADC$ (d) $A\overline{D} + ABC$

Q .16

A function is called self dual if "$m_i \in F$" Then "$m_{2^n-1-i} \in \overline{F}$". A Function 'F' is given as

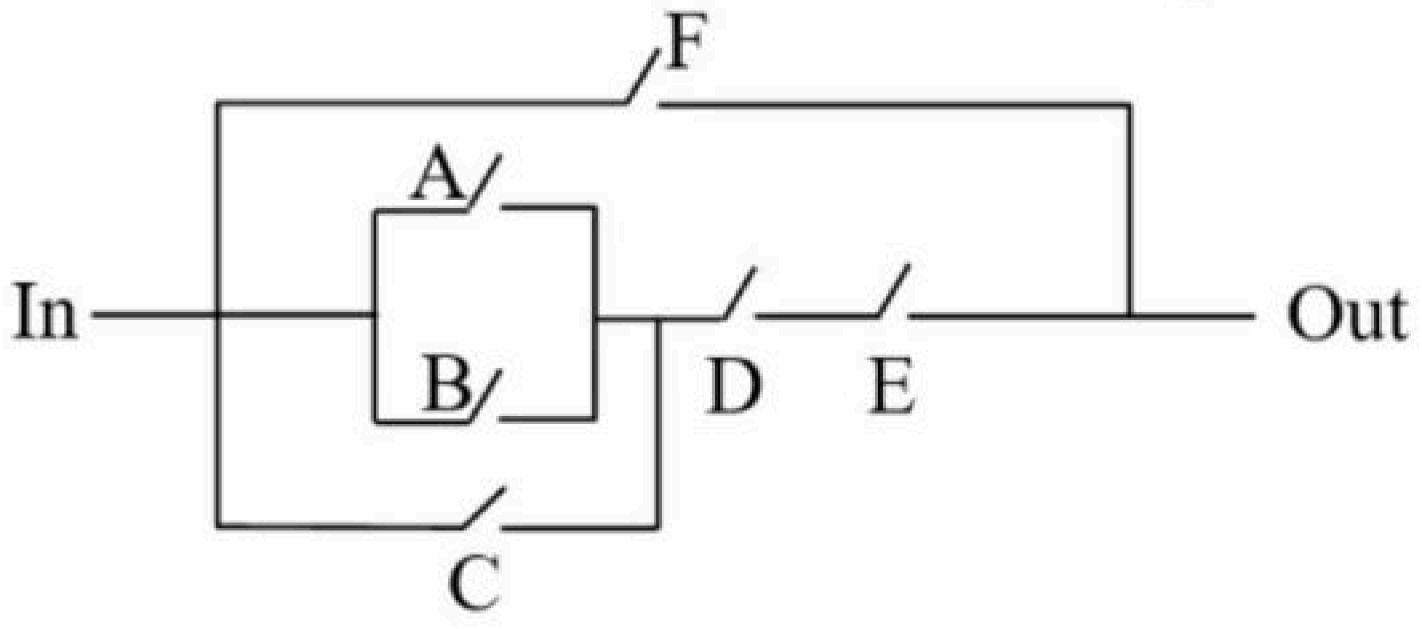
$F(a, b, c) = a\overline{b} + \overline{b}c + x$

Find the no of possible values of x

(A) 4 (B) 2 (C) 1 (D) 3

Q.17

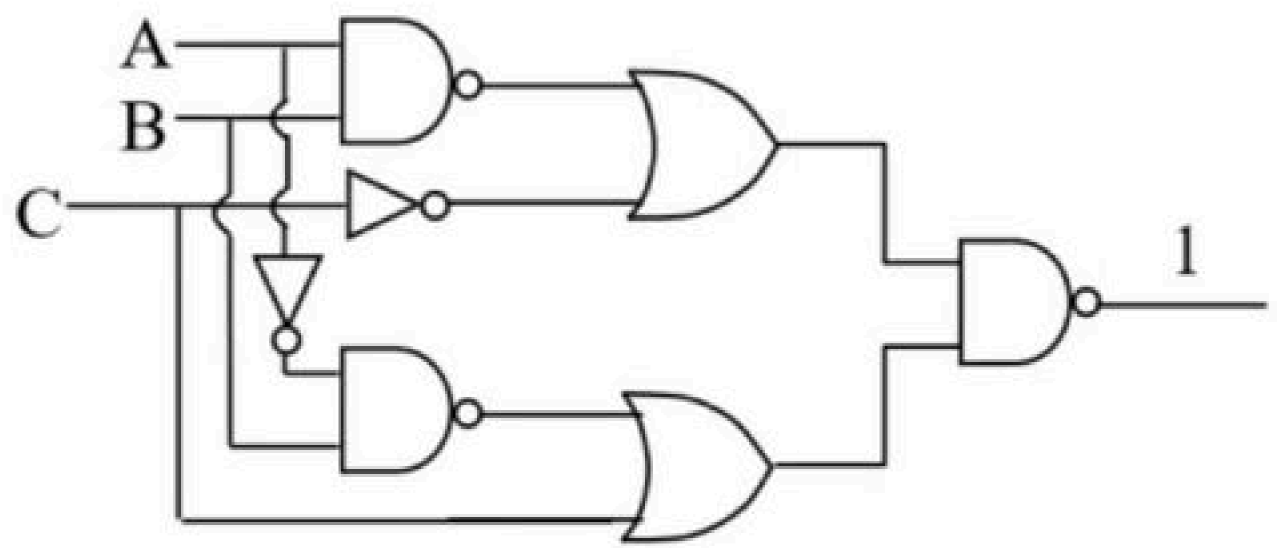
What is the dual of the Boolean function represented by the following circuit?



(A) (A+B+C) DE + F
(B) (AB + C) (D+E) + F
(C) (AB + C) DEF
(D) (ABC+D+E) F

Q.18

In the digital circuit shown below, the output is found to be logic '1' when A is logic '0'. The values of B and C are



(A) B = 1, C = 0 (B) B = 1, C = 1 (C) B = 0, C = 0 or 1 (D) Indeterminate

Q.19

The dual of the following function is

$$\overline{A\overline{B} + ABC} + A.(B + A\overline{B}) = 0$$

(A) $\overline{(A+\overline{B}).(A+B+C)}.(A+[B(A+\overline{B})]) = 0$

(B) $\overline{(A+\overline{B}).(A+B+C)}.(A+[B(A+\overline{B})]) = 1$

(C) $(A\overline{B}+ABC).(\overline{A}+\overline{B}(\overline{A}+B)) = 1$

(D) $(A\overline{B}+ABC).(\overline{A}+\overline{B}(\overline{A}+B)) = 0$

Q .20

Which of the following is/are self dual functions?

(A) $(A+B)(B+C)(C+A)$

(B) $(AB\overline{C}+\overline{B}\,\overline{C}+\overline{A}BC)+(A+B+\overline{C})(\overline{B}+\overline{C})(\overline{A}+B+C)$

(C) $X.(\overline{Y}+Z)(Y+\overline{Z})+\overline{X}.(\overline{Y}Z+Y\overline{Z})$

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

Digital Circuits

DPP-1

S. No	Topics	Problems Nos	Solution link
1	Boolean algebra	1 -60	Digital DPP-1
2	Boolean algebra	61- 80	Digital DPP-2
3	Boolean algebra Logic gates	81- 115 1- 10	Digital DPP-3
4	Logic gates	11-50	Digital DPP-4
5	Logic gates	51- 100	Digital DPP-5
6	Logic gates	101-121	Digital DPP-6
7	Logic gates	122-142	Digital DPP-7
8	Logic gates	143-163	Digital DPP-8
9	k- map	1- 14	Digital DPP-9
10	k- map	15- 34	Digital DPP-10
11	k- map	35- 39	Digital DPP-11
12	k- map	40-51	Digital DPP-12

1. A switching function f(A,B,C,D) = A'B'CD+A'BC'D+A'BCD+AB'C'D+AB'CD can also be written as

(a) Σm (1,3,5,7,9)

(b) Σ m (3,5,7,9,11)

(c) Σm (3,5,9,11,13)

(d) Σ m (5,7,9,11,13)

2. The switching function $f(A,B,C,D) = \sum m\ (5,9,11,14)$ can be written a

(a) $A'\ B\ C'\ D + A\ B'\ C'\ D + A\ B'\ CD + ABCD'$

(b) $A'\ B'\ C'\ D + AB'\ C'\ D + A'\ B'\ CD + ABCD'$

(c) $A'\ BC'\ D + A'\ BC'\ D' + AB'\ C\ D' + ABCD$

(d) None

3. The switching function $f(A,B,C) = (A+B'+C)(A'+B'+C)(A+B'+C')$ can also be written as

(a) $\Sigma m(2,3,6)$

(b) $\Sigma m(0,1,4,5,7)$

(c) $\Sigma m(1,2,5,6,7)$

(d) $\Sigma m(0,2,4,6)$

4. The other canonical form of $f(A,B,C) = \Sigma m\ (0,1,5,7)$ is

(a) $\Pi M\ (2,3,4,6)$

(b) $\Pi M\ (2,4,6,8)$

(c) $\Pi M\ (2,5,6,7)$

(d) $\Pi M\ (1,3,5,7)$

5. If a three variable switching function is expressed as the product of maxterms by $f(A,B,C) = \Pi M(0,3,5,6)$ then it can also be expressed as the sum of minterms by

(a) $\Sigma m\ (0,3,5,6)$ (b) $\Pi M(1,2,4,7)$

(c) $\Sigma m\ (1,2,4,7)$ (d) $\Pi M\ (1,2,4,7)$

6. The dual of Boolean theorem $x(y+z) = xy+xz$ is

(a) $x + yz = xy + xz$

(b) $x(y+z) = (x+y)(x+z)$

(c) $x+yz = (x+y)(x+z)$

(d) None

7. Given Boolean theorem $AB+A'C+BC = AB+A'C$ which of the following is true?

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

(b) $AB+A'C+BC = AB+BC$

(c) $AB+A'C+BC = (A+B)(A'+C)(B+C)$

(d) $(A+B)(A'+C)(B+C) = AB+A'C$

8. (A' + B' + C')' is equal to

(a) A' B' C'

(b) ABC

(c) A+B+C

(d) A'+B'+C'

9. $AB + A'C + BC$ is equivalent to

(a) $AB + BC$ (b) $AB + A'C$

(c) $A'C + BC$ (d) AC

10. The dual of a Boolean theorem is obtained by

(a) interchanging all zeros and ones only

(b) changing all zeros to ones only

(c) changing all ones to zeros only

(d) interchanging operators and identity elements

11. The number of min-terms after minimizing the following Boolean expression is ________.

$$[D' + AB' + A'C + AC'D + A'C'D]'$$

12. The simplified SOP (Sum of Product) form of the Boolean expression.

$$(P + \overline{Q} + \overline{R}).(P + \overline{Q} + R).(P + Q + \overline{R})$$

(a) $(\overline{P}Q + \overline{R})$ (b) $(P + \overline{Q}\,\overline{R})$

(c) $(\overline{P}Q + R)$ (d) $(PQ + R)$

13. The logic expression $F = XY+XZ'+YZ$ is known as

(a) SSOP form

(b) SOP form

(c) POS form

(d) SPOS form

14. The logic expression $F = (x+y+z)(x+y')(y+z')(x+z)$ is known as

(a) SOP form
(b) SSOP form
(c) SPOS form
(d) POS form

15. The logic expression $F = \sum m\,(0,3,6,7,10,12,15)$ is equivalent to

(a) $F = \Pi M(0,3,6,7,10,12,15)$

(b) $F = \Pi M(1,2,4,5,8,9,11,13,14)$

(c) $F = \Sigma m(0,1,5,6,7,12,15)$

(d) $F = \Sigma\, m\,(1,2,4,5,8,9,11,13,14)$

16. In Boolean Algebra `1' is called

(a) Additive identity
(b) Multiplicative identity
(c) Either 1 or 2
(d) None

17. In Boolean Algebra `0' is called

(a) Additive identity (b) Multiplicative identity

(c) Both 1 and 2 (d) None

18. A literal in Boolean algebra is a

(a) Primed or unprimed Boolean variable

(b) Primed Boolean variable only

(c) Unprimed Boolean variable only

(d) None

19. The Boolean expression $x + x' y$ is equal to

(a) x (b) $x+y$ (c) y (d) $x + y'$

20. The Boolean expression $(x+y)(x+z)$ is equal to

(a) $x+z$ (b) $x+y$ (c) $x+yz$ (d) $y+xz$

21. Identify number of literals in the given Boolean function $F = x'yz + xyz + xy'z$

(a) 5 (b) 4 (c) 3 (d) 6

22. A minterm is nothing but

(a) Standard sum term

(b) Standard product term

(c) May be standard sum term or product term

(d) None

23. A maxterm is nothing but a

(a) Standard sum term

(b) Standard product term

(c) May be standard sum term or product term

(d) None

24. The Boolean function expressed in standard sum of products form or standard product of sums form is called

(a) Canonical form (b) Conical form

(c) Both 1 and 2 (d) None

25. If P, Q, R are Boolean variables, then $(P+\overline{Q})(P.\overline{Q}+P.R)(\overline{P}.\overline{R}+\overline{Q})$ Simplifies to

(A) $P.\overline{Q}$ (B) $P.\overline{R}$

(C) $P.\overline{Q}+R$ (D) $P.\overline{R}+Q$

26. The min-term expansion of f (P, Q, R)= $PQ + Q\overline{R} + P\overline{R}$ is _______.

(A) $m_2 + m_4 + m_6 + m_7$

(B) $m_0 + m_1 + m_3 + m_5$

(C) $m_0 + m_1 + m_6 + m_7$

(D) $m_2 + m_3 + m_4 + m_5$

27. Boolean algebra is based on

(a) numbers (b) switch logic

(c) truth (d) symbols

28. For the identity $AB + \overline{A}C + BC = AB + \overline{A}C$, the dual form is

(a) $(A+B)\ (\overline{A}+C)\ (B+C) = (A+B)\ (\overline{A}+C)$

(b) $(\overline{A}+\overline{B})(A+\overline{C})(\overline{B}+\overline{C}) = (\overline{A}+\overline{B})\ (A+\overline{C})$

(c) $(A+B)\ (\overline{A}+C)\ (B+C) = (\overline{A}+\overline{B})(A+\overline{C})$

(d) $\overline{A}\,\overline{B}+A\,\overline{C}+\overline{B}\,\overline{C} = \overline{A}\,\overline{B}+A\overline{C}$

29. The minimized form of the Boolean expression $F(A, B, C) = \prod(0,2,3)$

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

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

(c) $\overline{AC} + B$

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

30. Which one of the following Boolean expressions is correct ?

(a) $\overline{x + y} = \bar{x}\,\bar{y}$

(b) $\overline{\bar{x} + y} = \bar{x}\,\bar{y}$

(c) $\overline{\overline{xy}} = \bar{x} + \bar{y}$

(d) $\overline{\bar{x} + \bar{y}} = \bar{x}\,\bar{y}$

31. A Boolean function can be expressed.

(a) as sum of maxterms or product of min-terms

(b) as product of maxterms or sum of min-terms

(c) partly as product of maxterms and partly as sum of min-terms

(d) partly as sum of maxterms and partly as product of min-terms

32. A function F (A, B, C) defined by three Boolean variables A, B and C when expressed as sum of products is given by:

$$F = \bar{A}.\bar{B}.\bar{C} + \bar{A}.B.\bar{C} + A.\bar{B}.\bar{C}$$

Where, $\bar{A}$, $\bar{B}$, and $\bar{C}$ and the complements of the respective variables. The product of sums (POS) form of the function F is

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

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

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

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

33. The compliment of the Boolean expression AB.($\overline{B}$C+AC) is

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

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

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

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

34. The product of sum expression of a Boolean function F (A, B, C) of three variables is given by $F(A, B, C) = (A + B + \bar{C}).(A + \bar{B} + \bar{C}).(\bar{A} + B + C).(\bar{A} + \bar{B} + \bar{C})$ The canonical sum of product expression of $F(A, B, C)$ is given by

(a) $\bar{A}\bar{B}C + \bar{A}BC + A\bar{B}\bar{C} + ABC$

(b) $\bar{A}\bar{B}\bar{C} + \bar{A}B\bar{C} + A\bar{B}C + AB\bar{C}$

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

(d) $\bar{A}\bar{B}\bar{C} + \bar{A}BC + AB\bar{C} + ABC$

35. Which one of the following gives the simplified sum of products expression for the Boolean function $F = m_0 + m_2 + m_3 + m_5$, where m_0, m_2, m_3 and m_5, are minterms corresponding to the inputs A, B and C with A as the MSB and C as the LSB?

(a) $\bar{A}B + \overline{A}\overline{B}\overline{C} + A\overline{B}C$ (b) $\overline{A}\overline{C} + \overline{A}B + A\overline{B}C$

(c) $\overline{A}\overline{C} + A\overline{B} + A\overline{B}C$ (d) $\overline{A}BC + \overline{A}\overline{C} + A\overline{B}C$

36. The Boolean expression $AB + A\bar{C} + BC$ simplifies to

(a) $BC + A\bar{C}$ (b) $AB + A\bar{C} + B$

(c) $AB + A\bar{C}$ (d) $AB + BC$

37. The Boolean expression $\overline{(a + \bar{b} + c + \bar{d}) + (b + \bar{c})}$ simplifies to

(a) 1 (b) $\overline{a.\,b}$

(c) $a.\,b$ (d) 0

38. The Boolean expression $XY + (X' + Y')Z$ is equivalent to

(a) $XYZ' + X'Y'Z$ (b) $X'Y'Z' + XYZ$

(c) $(X + Z)(Y + Z)$ (d) $(X' + Z)(Y' + Z)$

39. The Boolean expression

$F(X, Y, Z) = \bar{X}Y\bar{Z} + X\bar{Y}\bar{Z} + XY\bar{Z} + XYZ$

converted into the canonical product of sum (POS) form is

(a) $(X + Y + Z)(X + Y + \bar{Z})\ (X + \bar{Y} + \bar{Z})(\bar{X} + Y + \bar{Z})$

(b) $(X + \bar{Y} + Z)(\bar{X} + Y + \bar{Z})\ (\bar{X} + \bar{Y} + Z)(\bar{X} + \bar{Y} + \bar{Z})$

(c) $(X + Y + Z)(\bar{X} + Y + \bar{Z})\ (X + \bar{Y} + Z)(\bar{X} + \bar{Y} + \bar{Z})$

(d) $(X + \bar{Y} + \bar{Z})(\bar{X} + Y + Z)\ (\bar{X} + \bar{Y} + Z)(X + Y + Z)$

40. A function of Boolean variables X, Y and Z is expressed in terms of the min-terms as

$$F(X, Y, Z) = \sum(1,2,5,6,7)$$

Which one of the product of sums given below is equal to the function F(X, Y, Z)?

(a) $(\bar{X} + \bar{Y} + \bar{Z}).(\bar{X} + Y + Z).(X + \bar{Y} + \bar{Z})$

(b) $(X + Y + Z).(X + \bar{Y} + \bar{Z}).(\bar{X} + Y + Z)$

(c) $(\bar{X} + \bar{Y} + Z).(\bar{X} + Y + \bar{Z}).(X + \bar{Y} + Z).(X + Y + \bar{Z}).(X + Y + Z)$

(d) $(X + Y + \bar{Z}).(\bar{X} + Y + Z).(\bar{X} + Y + \bar{Z}).(\bar{X} + \bar{Y} + Z).(\bar{X} + \bar{Y} + \bar{Z})$

41. Consider the following Sum of Products expression, F.

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

The equivalent Product of Sums expression is

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

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

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

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

42. The Boolean expression $(X + Y)(X + \overline{Y}) + \overline{X\overline{Y} + \overline{X}}$ simplifies to

(a) X (b) Y

(c) XY (d) X + Y

43. If $X = 1$ in the logic equation

$[X + Z\{\overline{Y} + (\bar{Z} + X\overline{Y})\}]\{\overline{X} + \bar{Z}(X + Y)\} = 1$, then

(a) $Y = Z$ (b) $Y = \bar{Z}$

(c) $Z = 1$ (d) $Z = 0$

44. The Boolean expression $AC + B\bar{C}$ is equivalent to

(a) $\bar{A}C + B\bar{C} + AC$

(b) $\bar{B}C + AC + B\bar{C} + \bar{A}C\bar{B}$

(c) $AC + B\bar{C} + \bar{B}C + ABC$

(d) $ABC + \bar{A}B\bar{C} + A\bar{B}C + AB\bar{C}$

45. The simplified form of the Boolean expression $Y = (\bar{A}.BC + D)(\bar{A}.D + \bar{B}.\bar{C})$ can be written as

(a) $\bar{A}.D + \bar{B}.\bar{C}.D$

(b) $A.D + B.\bar{C}.D$

(c) $(\bar{A} + D)(\bar{B}.C + \bar{D})$

(d) $A.\bar{D} + B.C.\bar{D}$

46. If the functions W, X, Y and Z are as follows.

$$W = R + \bar{P}Q + \bar{R}S$$

$$X = PQ\bar{R}\bar{S} + \bar{P}\,\bar{Q}\,\bar{R}\,\bar{S} + P\bar{Q}\bar{R}\bar{S}$$

$$Y = RS + \overline{PR + P\bar{Q} + \bar{P}.\bar{Q}}$$

$$Z = R + S + \overline{PQ + \bar{P}.\bar{Q}.\bar{R} + P\bar{Q}.\bar{S}} \text{ then}$$

(a) $W = Z, X = \bar{Z}$ (b) $W = Z, X = Y$

(c) $W = Y$ (d) $W = Y = \bar{Z}$

47. The Boolean expression

$\bar{X}Y\bar{Z} + \bar{X}\bar{Y}Z + XY\bar{Z} + X\bar{Y}Z + XYZ$ Can be simplified to

(a) $X\bar{Z} + \bar{X}Z + YZ$ (b) $XY + \bar{Y}Z + Y\bar{Z}$

(c) $\bar{X}Y + YZ + XZ$ (d) $\bar{X}Y + Y\bar{Z} + \bar{X}Z$

48. The logic expression $y = A + \bar{A}B$ is equivalent to

(a) $y = AB$ (b) $y = \bar{A}B$

(c) $y = \bar{A} + B$ (d) $y = A + B$

49. The simplest form of the Boolean expression $AB\bar{C}\bar{D} + AB\bar{C}D + ABC\bar{D} + ABCD$ is

(a) AD (b) BC

(c) $A\bar{B}$ (d) AB

50. The expression $A + \overline{A}B$ is equivalent to

(a) $A + B$
(b) $AB + A$
(c) $A + \overline{B}$
(d) AB

51. From the truth table given below, choose the correct logic expression for Q

A	0	0	0	0	1	1	1	1
B	0	0	1	1	0	0	1	1
C	0	1	0	1	0	1	0	1
Q	0	0	0	1	0	1	1	1

(a) $AB + BC + CA$ (b) $A + B + C$

(c) $A\overline{B} + B\overline{C} + C\overline{A}$ (d) $\overline{AB} + \overline{BC} + \overline{CA}$

52. The minimal sum of products form $f = A\bar{B}CD + \bar{A}BC + \bar{A}\bar{B}C + BCD$ is

(a) $\overline{AC} + \overline{BD}$ (b) $\bar{A}C + CD$

(c) $AC + \bar{B}D$ (d) $A\bar{B} + C\bar{D}$

53. The term $AB + AC + B\overline{C}$ reduced to.

(a) $AB + CA$

(b) $AC + BC$

(c) $AC + B\overline{C}$

(d) $AB + \overline{B}\,\overline{C}$

54. If X, Y and Z are Boolean variables, then the expression $X(X+XY)\,Z(X+Y+Z)$ is equal to

(a) $X+\overline{X}Y$ (b) $X+Y+Z$

(c) XYZ (d) XZ

55. What is dual of A+[B+(AC)] + D

(a) A+[B(A+C)] + D

(b) A[B+AC] D

(c) A+[B(A+C)] D

(d) A[B(A+C)] D

56. The product-of-sum expressions for given truth table is:

X	Y	Z
0	0	1
0	1	0
1	0	1
1	1	0

(a) $(\overline{X}+\overline{Y})(X+Y)$ (b) $(X+\overline{Y})(\overline{X}+\overline{Y})$

(c) $(X+Y)(\overline{X}+\overline{Y})$ (d) None of the above

57. What is dual of $X+\overline{X}\,Y = X+Y$

(a) $X+Y = XY$

(b) $\overline{X} + XY = XY$

(c) $X(\overline{X} + Y) = XY$

(d) $X(\overline{X} + Y)+X+Y$

58. What is Boolean expression for a gating network that will have output 0 only, when $X=1$, $Y=1$, $Z=1$; $X=0$, $Y=0$, $Z=0$; $X=1.Y=0$, $Z=0$?

(a) $XYZ+\overline{X}\,\overline{Y}\,Z+X\overline{Y}Z$

(b) $XYZ\,(\overline{X}+\overline{Y}+Z)\,(X+\overline{Y}+Z)$

(c) $(\overline{X}+\overline{Y}+\overline{Z})\,(X+Y+Z)\,(\overline{X}+Y+Z)$

(d) $\overline{X}\,\overline{Y}\,Z+XYZ+\overline{X}\,YZ$

59. which one of the following is the dual form of the Boolean identity?

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

(a) $AB + \bar{A}C = AC + \bar{A}B$

(b) $(A+B) + (A+C) = (A+C)(A+B)$

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

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

60. In a digital system there are three inputs A, B and C. The output should be high when at-least two inputs are high, the Boolean expression for the output is.

(a) $AB+BC+AC$

(b) $ABC+AB\overline{C}+\overline{A}CB+A\overline{B}C$

(c) $AB\overline{C}+A\overline{B}C+\overline{A}BC$

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

61. The Boolean theorem:

$AB + \bar{A}C + BC = AB + \bar{A}C$ corresponds to

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

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

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

(d) $(A+B).(\bar{A}+C).(B+C) = (AB).(\bar{A}C)$

62. Which one of the following is equivalent to Boolean expression.

$Y = \overline{A}\,\overline{B} + \overline{B}\,\overline{C} + \overline{C}\,\overline{A}$ is?

(a) $\overline{AB + BC + CA}$

(b) $(\overline{A} + \overline{B})\,(B + \overline{C})\,(\overline{A} + \overline{C})$

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

(d) $\overline{(A + B)}\;\overline{(B + C)}\;\overline{(C + A)}$

63. Given Boolean theorem, $AB+\overline{A}C+BC = AB+\overline{A}C$. Which one of the following identities is true?

(a) $(A+B)(\overline{A}+C)(B+C) = (A+B)(\overline{A}+C)$

(b) $(AB + \overline{A}C + BC) = AB+BC$

(c) $AB+\overline{A}C+BC = (A+B)(\overline{A}+C)(B+C)$

(d) $(A+B)(\overline{A} + C)(B+C) = AB + \overline{A}C$

64. Consider the Boolean expression $X = ABCD + A\overline{B}CD + \overline{A}C\overline{B}D + \overline{A}BCD$. The simplified form of X is

(a) $\overline{C}+\overline{D}$ (b) BC

(c) CD (d) BC

65. The Boolean expression $(\overline{A} + B)(A+\overline{C})(\overline{B}+\overline{C})$ simplifies to

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

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

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

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

66. A, B and C are three Boolean variables. which one of the following Boolean expressions cannot be minimized any further?

(a) $Z = A\overline{B}\,\overline{C} + AB\overline{C} + ABC + \overline{A}\,\overline{B}\,\overline{C}$

(b) $Z = A\overline{B}\,C + AB\overline{C} + ABC + \overline{A}\,\overline{B}\,\overline{C}$

(c) $Z = A\overline{B}\,\overline{C} + \overline{A}\,\overline{B}\,C + A.B\,C + \overline{A}\,B\overline{C}$

(d) $Z = \overline{A}\,B\,\overline{C} + AB\overline{C} + ABC + \overline{A}\,\overline{B}\,C$

67. The Boolean function $(x + y)(\bar{x} + z)(y + z)$ is equal to which one of the following expressions?

(a) $(x + y)(y + z)$ (b) $(\bar{x} + z)(y + z)$

(c) $(x + y)(\bar{x} + z)$ (d) $(x + y)(y + \bar{z})$

68. $AB + \overline{A}C = (A + C)(\overline{A} + B)$ Which one of the following is the dual form of the Boolean identity given above?

(a) $AB + \overline{A}C = AC + \overline{A}B$

(b) $(A + B)(\overline{A} + C) = (A + C)(\overline{A} + B)$

(c) $(A + B)(\overline{A} + C) = AC + \overline{A}B$

(d) $AB + \overline{A}C = AB + \overline{A}C + BC$

69. What does the Boolean expression

$AD+ABCD+ACD+\overline{A}B+\overline{A}\,\overline{B}$ on minimization result into

(a) $A+D$ (b) $AD+\overline{A}$

(c) AD (d) $\overline{A}+D$

70. If A and B are Boolean variables, then what is $(A + B).(A + \overline{B})$ equal to?

(a) B (b) A

(c) A + B (d) AB

71. The Boolean functions can be expressed in canonical SOP (Sum Of Products) and POS (Product Of Sums) form. For the functions, $Y = A + \overline{B}\,C$, which are such two forms

(a) $Y = \sum (1,2,6,7)$ and $Y = \prod (0,2,4)$

(b) $Y = \sum (1,4,5,6,7)$ and $Y = \prod (0,2,3)$

(c) $Y = \sum (1,2,5,6,7)$ and $Y = \prod (0,1,3)$

(d) $Y = \sum (1,2,4,5,6,7)$ and $Y = \prod (0,2,3,4)$

72. The Boolean function $A + BC$ is a reduced form of which one of the following.

(a) $AB + BC$ (b) $\overline{A}B + A\overline{B}C$

(c) $(A + B).(A + C)$ (d) None of the above

73. Which one of the following statements is not correct.

(a) $X + \overline{X}Y = X$

(b) $X(\overline{X} + Y) = XY$

(c) $XY + X\overline{Y} = X$

(d) $ZX + Z\overline{X}Y = ZX + ZY$

74. Which of the following Boolean Algebra rules is correct?

(a) $A.\overline{A} = 1$

(b) $A + AB = A + B$

(c) $A + \overline{A}\ B = A + B$

(d) $A\,(A + B) = B$

75. What are the ultimate purposes of Minimizing logic expressions?

1. To get a small size expression.
2. To reduce the number of variables in the given expression.
3. To implement the function of the logic expression with least hardware.
4. To reduce the expression for making it feasible for hardware implementation.

Select the correct answer from the codes given below:

(a) 1 only (b) 2 and 3

(c) 3 only (d) 3 and 4

76. The Boolean expression $\overline{A+\overline{B}+C}+\overline{\overline{A}+\overline{B}+C}+\overline{A+\overline{B}+\overline{C}}+ABC$ reduces to:

(a) A (b) B

(c) C (d) A + B + C

77. The standard SOP expression for Boolean expression $A\overline{B} + AC + BC$ is:

(a) $A\overline{B}C + \overline{A}BC + A\overline{B}\,\overline{C} + ABC$

(b) $AB\overline{C} + \overline{A}BC + ABC$

(c) $A\overline{B}C + AB\overline{C} + ABC$

(d) $\overline{A}\,\overline{B}C + AB\overline{C} + A\overline{B}\,\overline{C}$

78. The complement of the expression $Y = ABC + AB\overline{C} + \overline{A}\,\overline{B}\,C + \overline{A}BC$ is:

(a) $(A + \overline{B})(A + \overline{C})$ (b) $(\overline{A} + B)(A + C)$

(c) $(A + \overline{B})(\overline{A} + C)$ (d) $(\overline{A} + \overline{B})(A + \overline{C})$

79. The logic function $f = \overline{(x.\overline{y} + \overline{x}.y)}$ is the same as

(a) $f = (x + y)(\overline{x} + \overline{y})$

(b) $f = \overline{(\overline{x} + \overline{y})(x + y)}$

(c) $f = \overline{(x.y)}(\overline{x}.\overline{y}$

(d) None of the above

80. If the Boolean expression $\overline{P}Q + QR + PR$ is Minimized, the expression becomes:

(a) $\overline{P}Q + QR$ (b) $\overline{P}Q + PR$

(c) $QR + PR$ (d) $\overline{P}Q + QR + PR$

81. The Boolean equation $X = [(A + \overline{B})(B + C)]\, B$ can be simplified to

(a) $X = \overline{A}\, B$ (b) $X = A\, \overline{B}$

(c) $X = A\, B$ (d) $X = \overline{A}\, \overline{B}$

82. The correct expression is

(a) $\overline{A}\,B + A\,\overline{B} = \overline{AB}\,(A + B)$

(b) $\overline{A}B + \overline{A}B = AB\,(\overline{A} + \overline{B})$

(c) $\overline{A}\,B + A\,\overline{B} = AB\,(\overline{A} + \overline{B})$

(d) $\overline{A}B + \overline{A}B = \overline{AB}\,(A + B)$

83. Simplified form of the logic expression $(A + \overline{B} + C)(A + \overline{B} + \overline{C})(A + B + C)$ is

(a) $\overline{A}B + \overline{C}$ (b) $A + \overline{B}C$

(c) A (d) $AB + \overline{C}$

84. Logic function $(\overline{A} + B)(A + B)$ can be reduced to:

(a) B (b) $\overline{B}$

(c) A (d) $\overline{A}$

85. Logic function $A\overline{B}D + A\overline{B}\overline{D}$ can be reduced to:

(a) $\overline{A}\,\overline{B}$ (b) $A\overline{B}$

(c) $\overline{B}\,\overline{D}$ (d) $A\overline{D}$

86. The logic function $f(A, B, C, D) = (\overline{A} + BC)(B + CD)$ can be expressed to:

(a) $\overline{A}B + BC + \overline{A}CD + BCD$

(b) $AB + A\overline{B} + A\overline{C}D + BCD$

(c) $AB + \overline{AB} + \overline{A}CD + B\overline{C}D$

(d) $A\overline{B} + \overline{A}B + \overline{A}CD + BCD$

87. The logic function (A + B) can be expressed in terms of min terms as:

(a) $A\overline{B} + B\overline{A}$

(b) $\overline{A}B + \overline{B}A + AB$

(c) $\overline{A}\,\overline{B} + \overline{A}B$

(d) $AB + \overline{B}A$

88. The min terms for AB + ACD are

(a) $\overline{A}\,\overline{B}CD + AB\overline{C}D + A\overline{B}C\overline{D} + A\overline{B}C\overline{D} + \overline{A}BCD$

(b) $AB\,\overline{C}\,\overline{D} + AB\overline{C}D + ABC\overline{D} + ABCD + A\overline{B}CD$

(c) $A\overline{B}CD + AB\overline{C}D + ABC\overline{D} + \overline{A}BCD + A\overline{B}C\overline{D}$

(d) $AB\overline{C}D + A\overline{B}CD + \overline{A}BCD + ABC\overline{D} + \overline{A}\,\overline{B}CD$

89. On simplification of expression $Y = \overline{(A \cdot B + \overline{C})(\overline{A + B} + C)}$ using Boolean algebra, the solution is

(a) $(A \cdot B + C)(A + B \cdot C)$

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

(c) $(A \cdot B + \overline{C})(A \cdot C + \overline{B})$

(d) $(B \cdot C + \overline{A})(A \cdot B + \overline{C})$

90. The function $Y = A + \overline{B} \cdot C$ in canonical sum of product form is

(a) $Y = \sum m(1,3,5,6,7)$

(b) $Y = \sum m(1,4,5,6,7)$

(c) $Y = \sum m(2,3,5,6)$

(d) $Y = \sum m(2,3,5,7)$

91. The simplified form of the Boolean expression $AB + A(B + C) + B(B + C)$ is given by

(a) $AB + AC$ (b) $B + AC$

(c) $BC + AC$ (d) $AB + C$

92. Product of Max terms representation for the Boolean function $F = \overline{B}D + \overline{A}D + BD$ is

(a) $\prod M(1,3,5,7)$

(b) $\prod M(0,2,4,6)$

(c) $\prod M(0,1,2,3)$

(d) $\prod M(4,5,6,7)$

93. Simplified form of the Boolean expression $Y = \overline{(A \cdot B + \overline{C})(\overline{A + B} + C)}$ is

(a) $\overline{A}\,\overline{C} + A\overline{C} + \overline{BC} + \overline{B}C$

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

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

(d) $A(B + C)$

94. What is the function $Y = A + \overline{B}C$ in Product-Of-Sums (POS) form?

(a) $M_6\,M_5\,M_4\,M_3$ (b) $M_3\,M_2\,M_1\,M_0$

(c) $M_0\,M_2\,M_3$ (d) $M_4\,M_3\,M_2\,M_1$

95. In the negative logic system,

(a) The more negative of two logic levels represent a logic ‘1’ state

(b) The more negative of two logic levels represent a logic ‘0’ state

(c) All input and output voltage levels are negative

(d) The output is always complement of the intended logic function.

96. What is the Boolean expression for the truth table shown below?

A	0	0	0	0	1	1	1	1
B	0	0	1	1	0	0	1	1
C	0	1	0	1	0	1	0	1
f	0	0	0	1	0	0	1	0

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

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

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

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

97. A 3-variable truth table has a high output for the inputs: 010, 011 and 110. The Boolean expression for the Sum of Products (SOP) can be written as:

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

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

(c) $\overline{AB} + BC$

(d) $AB + \overline{BC}$

98. Four logical expressions are given below:

1. $\overline{A}.\overline{B}.\overline{C}.\overline{D}.\overline{E}.\overline{F}.\overline{G}.\overline{H}$
2. $\overline{AB}.\overline{CD}.\overline{EF}.\overline{GH}$
3. $\overline{A}+\overline{B}+\overline{C}+\overline{D}+\overline{E}+\overline{F}+\overline{G}+\overline{H}$
4. $(\overline{A}+\overline{B})(\overline{C}+\overline{D})(\overline{E}+\overline{F})(\overline{G}+\overline{H})$

Two of these expressions are equal.

(a) 1 and 2 (b) 3 and 4

(c) 1 and 3 (d) 2 and 4

99. The expression $(X+Y)(X+\overline{Y})(\overline{X}+Y)$ is equivalent to

(a) $\overline{X}\,\overline{Y}$ (b) $\overline{X}\,Y$

(c) $X\overline{Y}$ (d) XY

100. In Boolean algebra if $F=(A+B)(\overline{A}+C)$ then

(a) $F = AB+\overline{A}C$

(b) $F = AB+\overline{A}\,\overline{B}$

(c) $F = AC+\overline{A}B$

(d) $F = A\overline{A}+\overline{A}B$

101. The simplified form of a logic function $Y = \overline{(\overline{A\overline{B}})\,(\overline{\overline{A}\,B})}$

(a) A+B

(b) AB

(c) $\overline{A} + \overline{B}$

(d) $\overline{A}\,B + A\overline{B}$

102. The reduced form of the Boolean expression $A[B+C\overline{(AB + AC)}]$ is.

(a) $\overline{A}B$ (b) $A\overline{B}$

~~(c)~~ AB (d) $AB+B\overline{C}$

$$f = A[B + C(\overline{A}+\overline{B})(\overline{A}+\overline{C})]$$

$$= A[B + C(\overline{A} + \overline{B}\,\overline{C})]$$

$$= A[B + \overline{A}C + 0] = AB$$

103. Which of the following expression is not correct?

(a) $X+\overline{X}Y = X + y$

(b) $X.(\overline{X} + Y) = XY$

(c) $X+X\overline{Y}=X$

(d) $ZX+Z\overline{X}Y = ZX+ZY$

104. The Boolean expression $\overline{Y}\,\overline{Z} + \overline{X}\,\overline{Z} + \overline{X}\,\overline{Y}$ is logically equal to

(a) $YZ + \overline{X}$ ✗. (b) $YZX + \overline{X}\,\overline{Y}\,\overline{Z}$ ✗

(c) $YZ + XZ + XY$ ✓ (d) $X\overline{Y}\,\overline{Z} + \overline{X}\,\overline{Y}\,\overline{Z} + \overline{X}\,Y\,\overline{Z} + \overline{X}\,\overline{Y}\,Z$ ✓

105. The function $F = AB\overline{C} + ABC + \overline{A}BC + \overline{A}B\overline{C}$ can be reduced to which one of the following

(a) $F = A$ (b) $F = AB$

(c) $F = ABC$ ~~(d) F~~ $= B$

$F = AB + \overline{A}B$

$\boxed{F = B}$

106. What is the simplified form of the Boolean expression $T=(X+Y)(X+\overline{Y})(\overline{X}+Y)$

(a) $\overline{X}\,\overline{Y}$ (b) $\overline{X}\,Y$

~~(c) XY~~ (d) $X\overline{Y}$

$(x+0)(\bar{x}+y) = xy$

107. Match List-I (expression 1) with List-II (expression 2) and select the correct answer using the codes given below the Lists:

List-I		List-II
2	A. $ABC + AB\overline{C} + A\overline{B}C$ = AB + AC	1. $\overline{A} + BC$
3	B. $\overline{A}B\overline{C} + AB\overline{C} + B\overline{C}$ = $B\overline{C}$	2. $A(B+C)$
4	C. $\overline{A}BC + A\overline{B}C + AB\overline{C} + ABC$	3. $B\overline{C}$
1	D. $\overline{A}\,\overline{B} + \overline{A}\,B + ABC$ = $\overline{A}$ + ABC	4. $AB+BC+AC$

$\overline{A}$ + BC

Codes:

	A	B	C	D
(a)	2	1	4	3
(b)	4	3	2	1
(c)	2	3	4	1
(d)	4	1	2	3

108. The Boolean expression $A.B+\overline{A}\,\overline{B}$ is logically equivalent to which of the following?

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

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

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

(d) $\overline{A+B}\,.\,\overline{\overline{A}+\overline{B}}$

$$y = A \odot B = \overline{(A \oplus B)}$$

$$y = (A+\overline{B})(\overline{A}+B)$$

109. The Boolean expression $F = \overline{A + \overline{B} + C} + \overline{\overline{A} + \overline{B} + C} + \overline{A + \overline{B} + \overline{C}} + ABC$ reduces to

(a) A
(b) B
(c) C
(d) A+ B+C

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

$= B\overline{C} + AB + BC$

$F = B + AB = B$

110. The logic function A+BC is the simplified form of which of the following?

(a) $AB + BC$ (b) $\overline{A}B + A\overline{B}C$

(c) $\overline{ABC}$ (d) $(A+B)(A+C)$

$$A + BC = (A+B)(A+C)$$

111. The logical expression, $A\,B\,\overline{C} + A\,\overline{B}C + A\,\overline{B}\bar{C}$ is equivalent to

(a) $\overline{A}\,(B+C)$ (b) $\overline{A} + \overline{B} + \overline{C}$

(c) $\overline{A}\,\overline{B}\,\overline{C}$ (d) $A\,(\overline{C} + \overline{B})$

$$A\overline{C} + A\overline{B}C = A\left[\overline{C} + C\overline{B}\right]$$

$$= A\left[\overline{C} + \overline{B}\right]$$

112. Let * be defined as x*y= $\overline{x}$ + y. Let z = x*y. value of z*x is

(A) x + y ~~(B)~~ x

(C) 0 (D) 1

$x * y = \overline{x} + y$

$z = x * y = \overline{x} + y$

$z * x = \overline{z} + x$

$= \overline{\overline{x} + y} + x$

$= x\overline{y} + x = \underline{x}$

113.Let f(A, B) = A' + B. Simplified expression for function f (f (x + y, y),z) is

(A) x'+ z (B) xyz

~~(C)~~ xy'+ z (D) None of these

$$f(A, B) = \overline{A} + B$$

$$f(x+y, y) = \overline{x+y} + y = \overline{x}\,\overline{y} + y = \overline{x} + y$$

$$f(\overline{x}+y, z) = \overline{\overline{x}+y} + z = x\overline{y} + z$$

114. The Boolean function $x'y' + xy + x'y$ is equivalent to

(A) $x' + y'$ (B) x + y

(C) $x + y'$ ~~(D) $x' + y$~~

$$\bar{x}\bar{y} + xy + \bar{x}y.$$

$$y + \bar{x}$$

115. Given f_1, f_2, f_3 and $f = f_1 f_2 + f_3$ in canonical sum of products form (in decimal) for the circuit $f_1 = \sum m(4,5,6,7,8)$;

$f_2 = \sum m(1,6,15)$

$f = \sum m(1,6,8,15)$

Then f_3 is

$f = f_1 f_2 + f_3$

$f_3 = \Sigma m(1, 6, 8, 15)$

(or)

$f_3 = \Sigma m(1, 8, 15)$

$(1, 6, 8, 15) = (6) + (1, 6, 8, 15)$

116. Select the boolean function(s) equivalent to $\boxed{x + yz}$ where x, y and z are boolean variables, and + denotes logical OR operation

GATE -22 (EC)

(a) $x + y + xy$

(b) $(x + y)(x + z)$ ✓

(c) $x + xy + yz$

(d) $x + xz + xy$

$x(1+y) + yz$

$x + yz$

$(x+y)(x+z)$

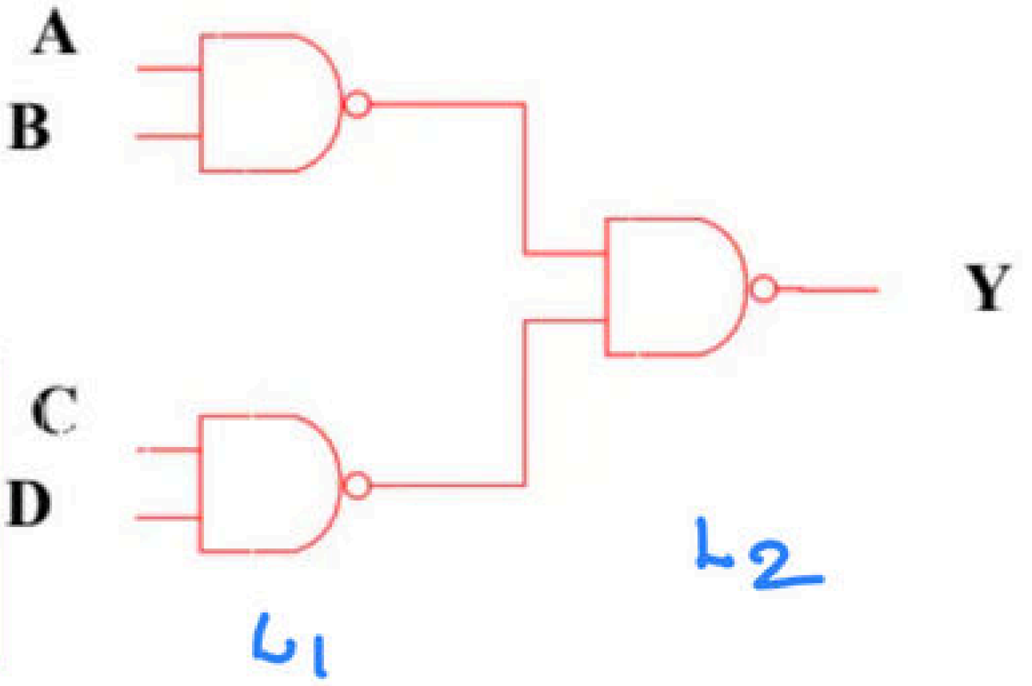
Logic Gates

1. In the logic circuit shown in the figure, Y is given by.

(a) Y=ABCD (b) Y =(A+B) (C+D)

(c) Y=A+B+C+D (d) Y=AB+CD

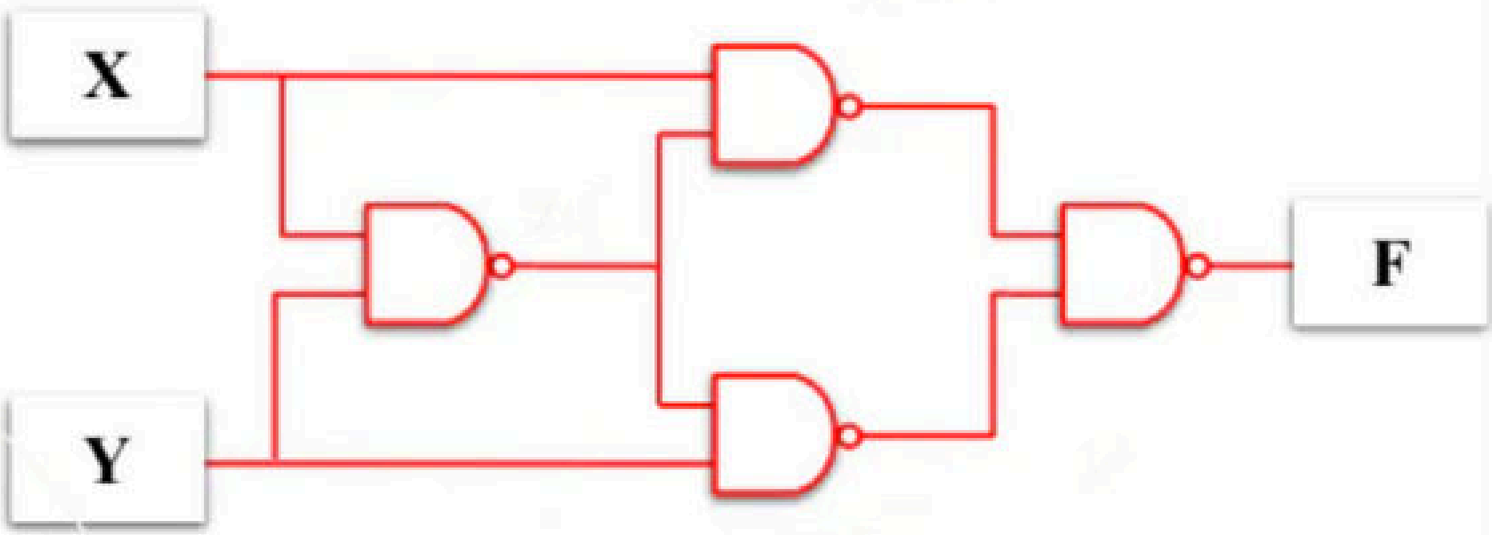
2- Level AND- OR Logic ≡ 2- Level NAND- NAND



2. The Boolean function F(X, Y) realized by the given circuit is:

(a) $\bar{X}Y + X\bar{Y}$ (b) $\bar{X}\bar{Y} + XY$

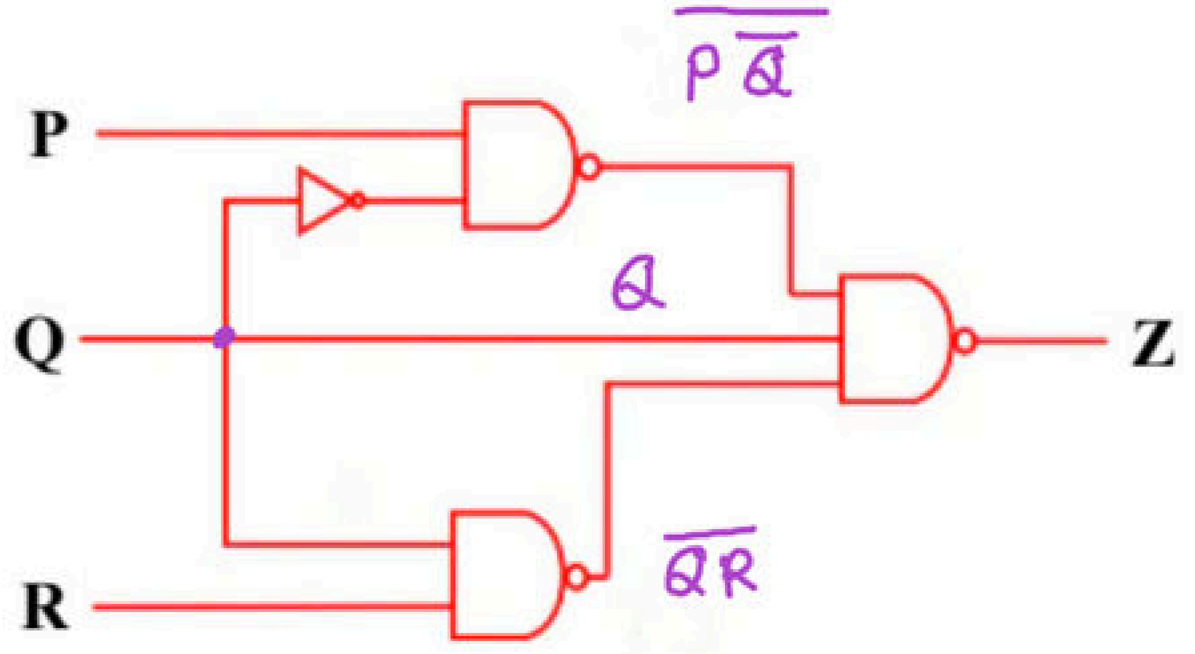
(c) $X + Y$ (d) $\bar{X}.\bar{Y}$



3. For a 3-input logic circuit shown below, the output Z can be expressed as

(a) $Q + \overline{R}$ (b) $P\overline{Q} + R$

~~(c)~~ $\overline{Q} + R$ (d) $P + \overline{Q} + R$



$$Z = \overline{\overline{P\overline{Q}} \cdot Q\ \overline{QR}}$$

$$= P\overline{Q} + \overline{Q} + QR.$$

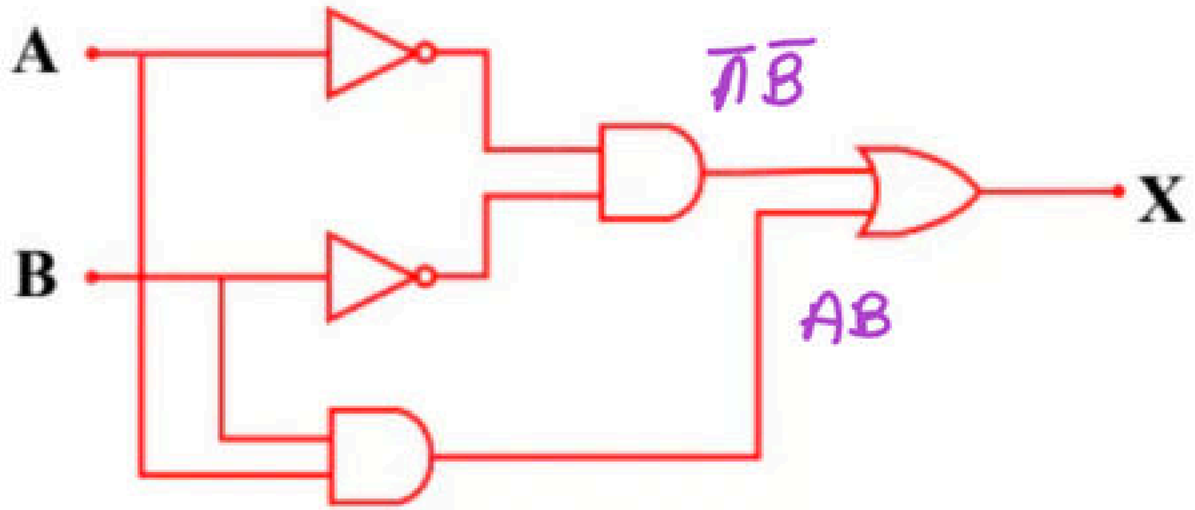
$$= \overline{Q} + QR$$

$$= \overline{Q} + R$$

4. A and B are the logical inputs and X is the logical output shown in the figure.

(a) $X = \bar{A}B + \bar{B}A$ (b) $X = AB + \bar{B}A$

(c) $X = AB + \bar{B}\bar{A}$ (d) $X = \overline{AB} + \bar{B}A$

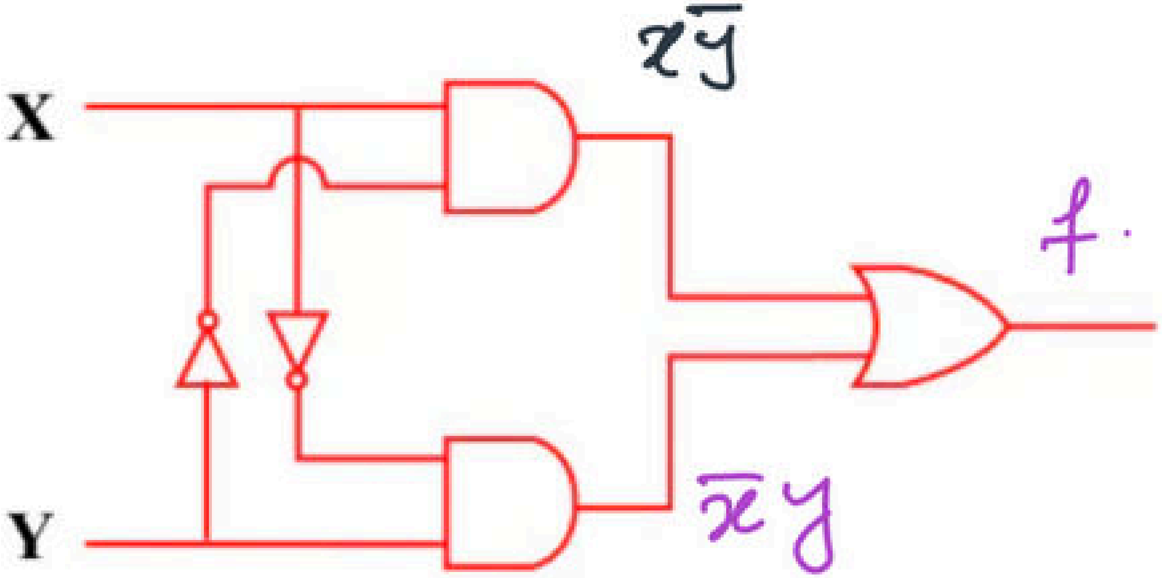


$$X = \bar{A}\bar{B} + AB = A \odot B$$

5. The logic evaluated by the circuit at the output is

(a) $X\overline{Y} + Y\overline{X}$ (b) $(\overline{X+Y})XY$

(c) $\overline{XY} + XY$ (d) $\overline{X}Y + X\overline{Y} + X + Y$

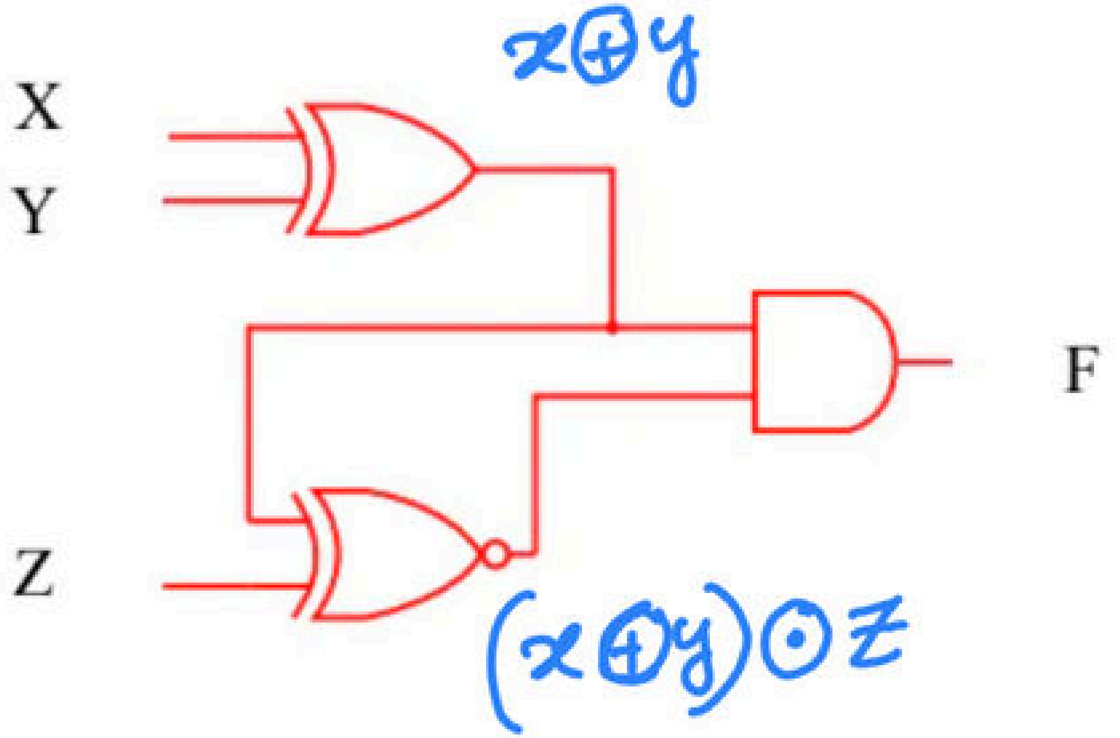


$$f = \bar{x}y + x\bar{y} = x \oplus y$$

6. The output F in the digital logic circuit shown in the figure is

(a) $F = \bar{X}YZ + X\bar{Y}Z$ (b) $F = \bar{X}Y\bar{Z} + X\bar{Y}Z$

(c) $F = \overline{XYZ} + XYZ$ (d) $F = \overline{XYZ} + XYZ$



$$F = (x \oplus y)\left((x \oplus y) \odot z\right)$$

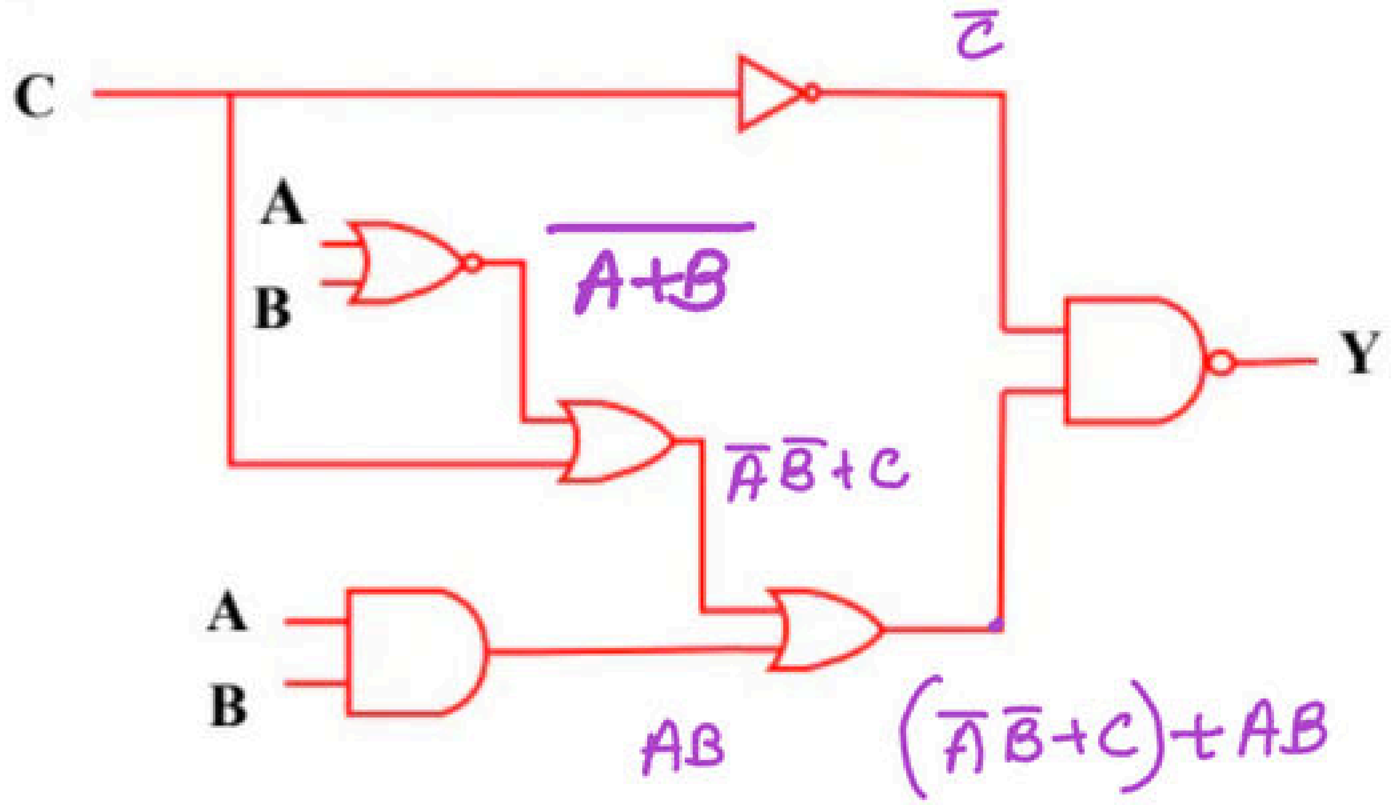
$$F = x \oplus y\left[\overline{(x \oplus y)}\,\bar{z} + (x \oplus y) z\right]$$

$$F = (x \oplus y) z = \bar{x} y z + x \bar{y} z.$$

7. In the circuit shown in the figure, if C = 0, the expression for Y is

(a) $Y = A\overline{B} + \overline{A}B$ (b) $Y = A + B$

(c) $Y = \overline{A} + \overline{B}$ (d) $Y = AB$



$$Y = \overline{(\overline{A}\,\overline{B}+C+AB)\,\overline{C}}$$

$$Y = \overline{\overline{A}\,\overline{B}\,\overline{C} + AB\overline{C}}$$

$$Y = \overline{\overline{A}\,\overline{B} + AB} = \overline{A \odot B}$$

$$Y = A \oplus B =$$

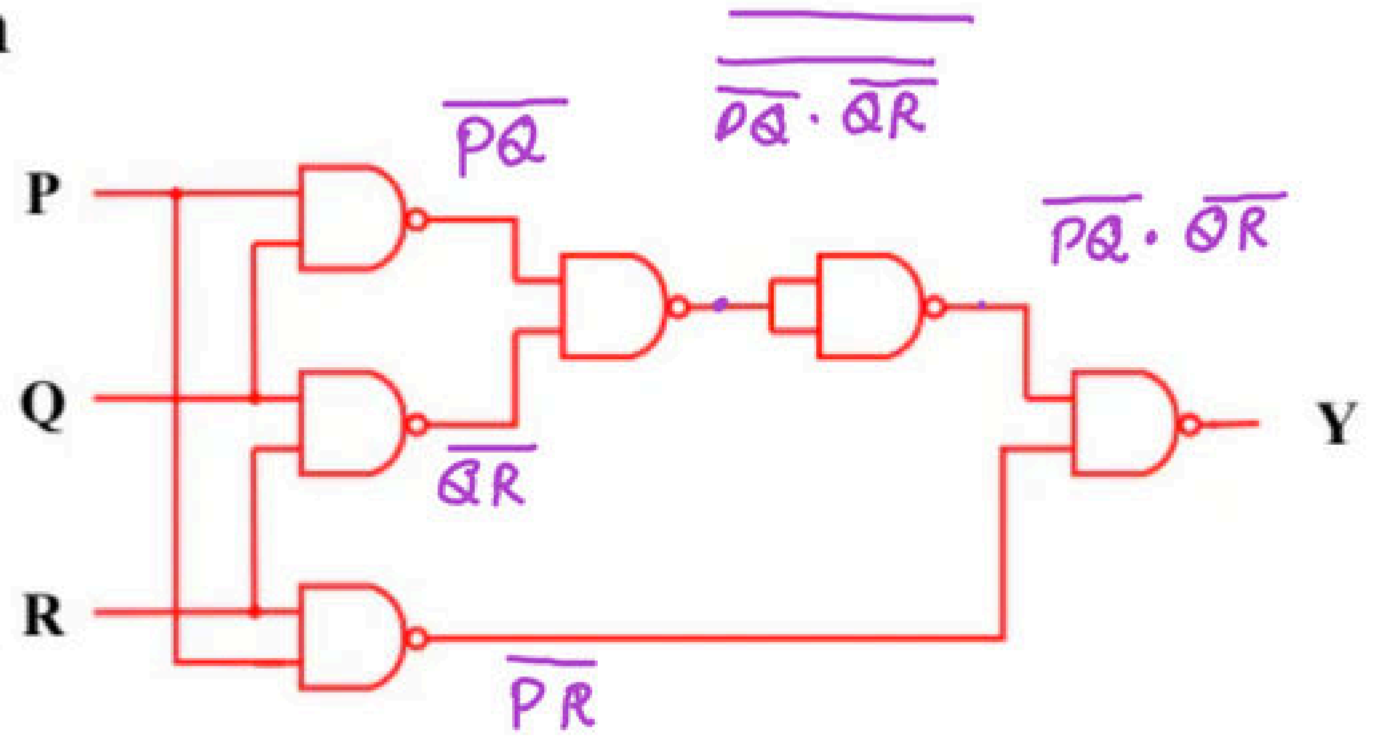
8. The output Y in the circuit below is always '1' when

(a) Two or more of the inputs P, Q, R are '0'

(b) Two or more of the inputs P, Q, R are '1'

(c) Any odd number of the inputs P, Q, R is '0'

(d) Any odd number of the inputs P, Q, R is '1'



$Y = \overline{\overline{PQ}\cdot\overline{QR}\cdot\overline{PR}}$

$\boxed{Y = PQ + QR + PR.}$

$Y = \Sigma m(3, 5, 6, 7)$

→ self dual expression

→ majority logic ckt.

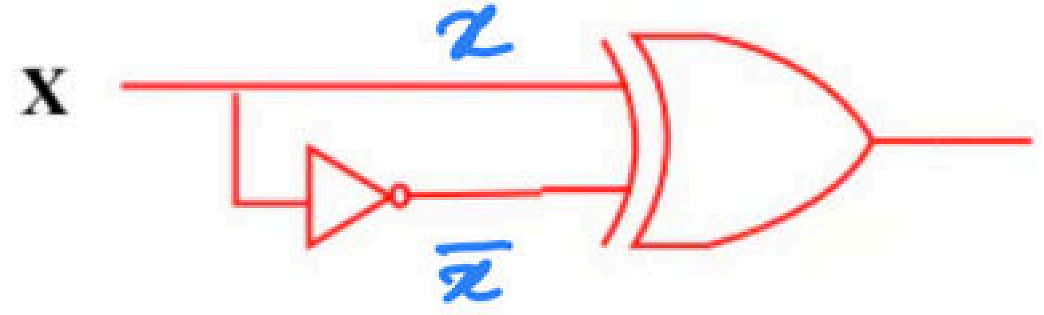
→ carry of FA.

→ mobile pin.

9. The output Y of the logic circuit give below is

(a) 1 (b) 0

(c) X (d) $\overline{X}$



$\boxed{x \oplus \overline{x} = 1}$

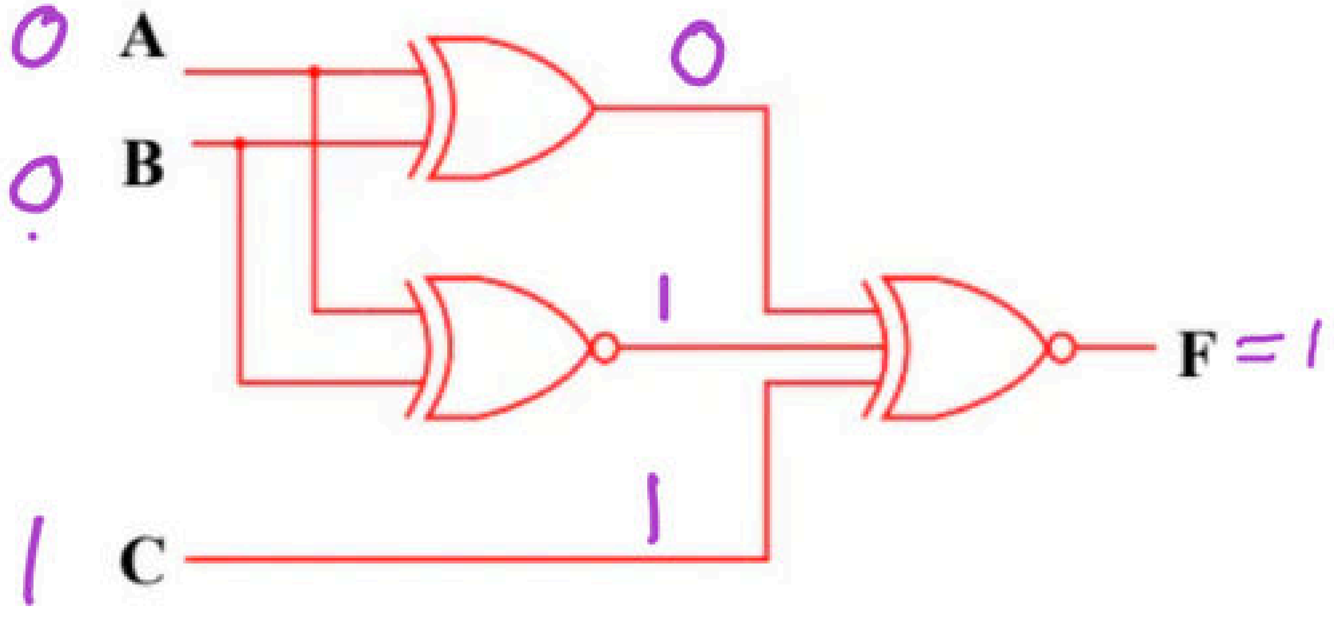
10. For the output F to be 1 in the logic circuit shown, the input combination should be

(a) $A = 1, B = 1, C = 0$ ✗

(b) $A = 1, B = 0, C = 0$ ✗

(c) $A = 0, B = 1, C = 0$ ✗

(d) $A = 0, B = 0, C = 1$



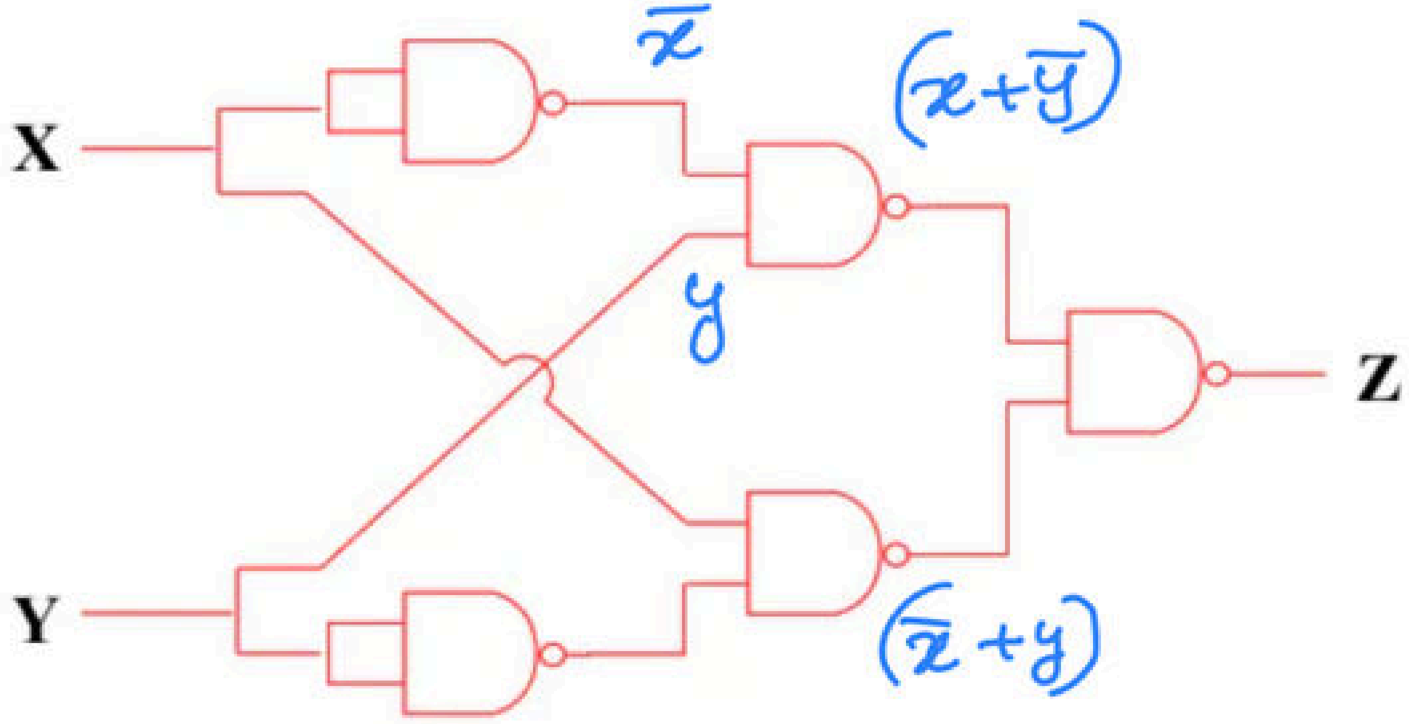
X-NOR

Y = 1, for even no. of 1's

11. The logic gate circuit shown in the figure realizes the function

(a) XOR (b) XNOR

(c) Half adder (d) Full adder

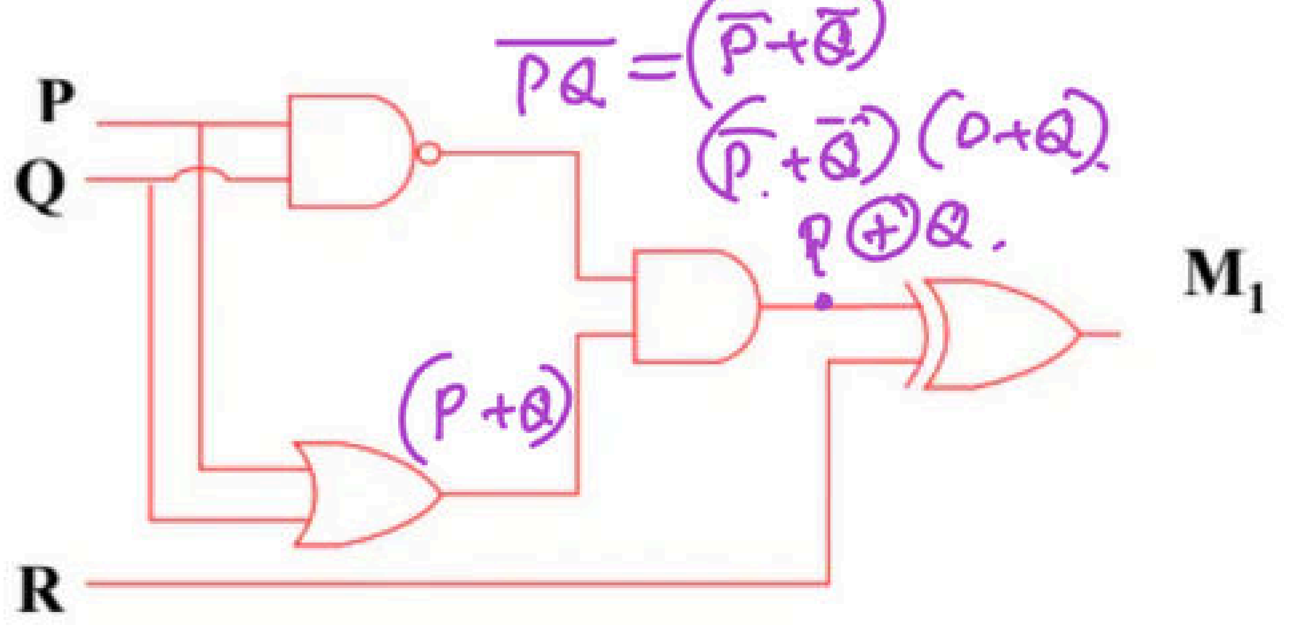


$$Z = \overline{(x+\bar{y})(\bar{x}+y)}$$

$$Z = \overline{\bar{x}\bar{y} + xy}$$

$$Z = \overline{x \odot y} = x \oplus y.$$

12. Which of the following Boolean Expression correctly represents the relation between P, Q, R and M_1?



(a) $M_1 = (P + Q) \oplus R$

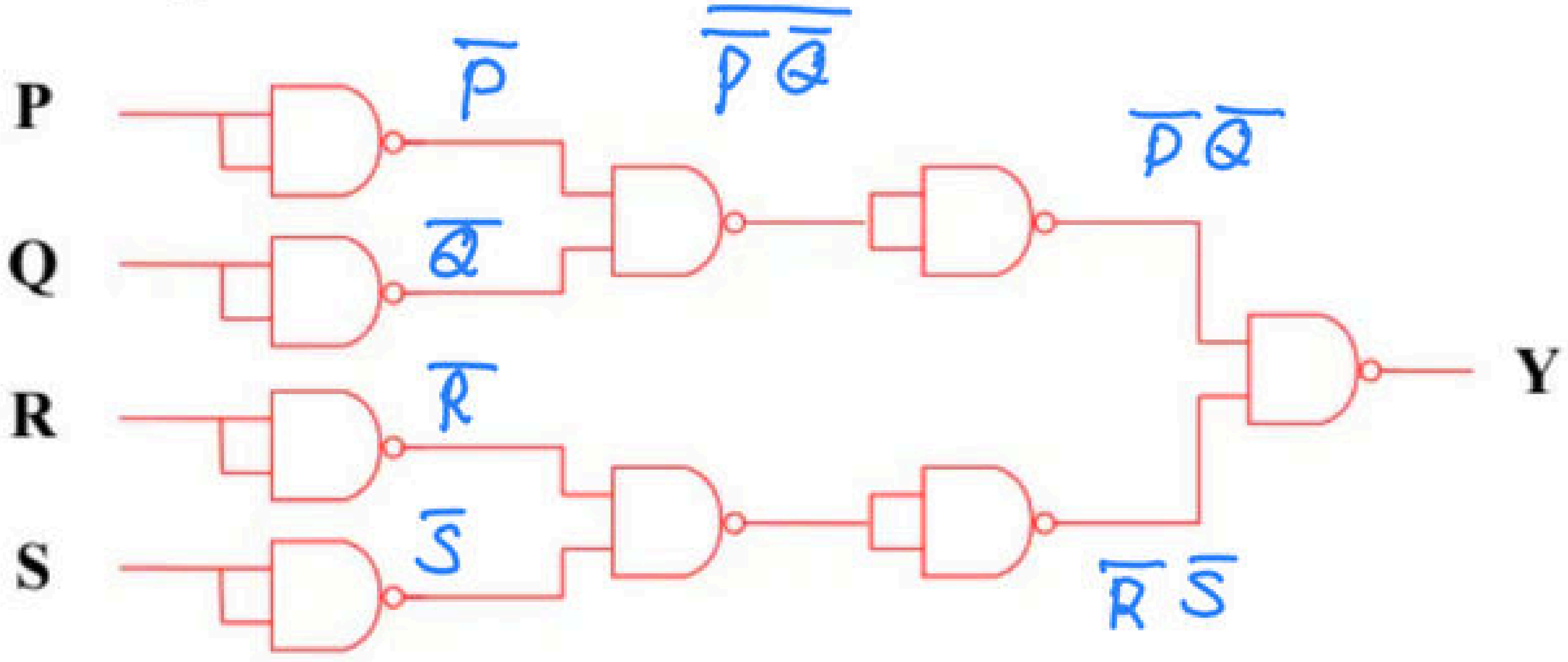
(b) $M_1 = (P \cdot Q) \oplus R$

(c) $M_1 = (P \odot Q) \oplus R$

(d) $M_1 = (P \oplus Q) \oplus R$

$$\boxed{M_1 = (P \oplus Q) \oplus R.}$$

13. For the circuit shown in figure, the Boolean expression for the output Y in terms of inputs P. Q, R and S is



(a) $\bar{P}+\bar{Q}+\bar{R}+\bar{S}$

(b) $P+Q+R+S$

(c) $(\bar{P}+\bar{Q})(\bar{R}+\bar{S})$

(d) $(P+Q)(R+S)$

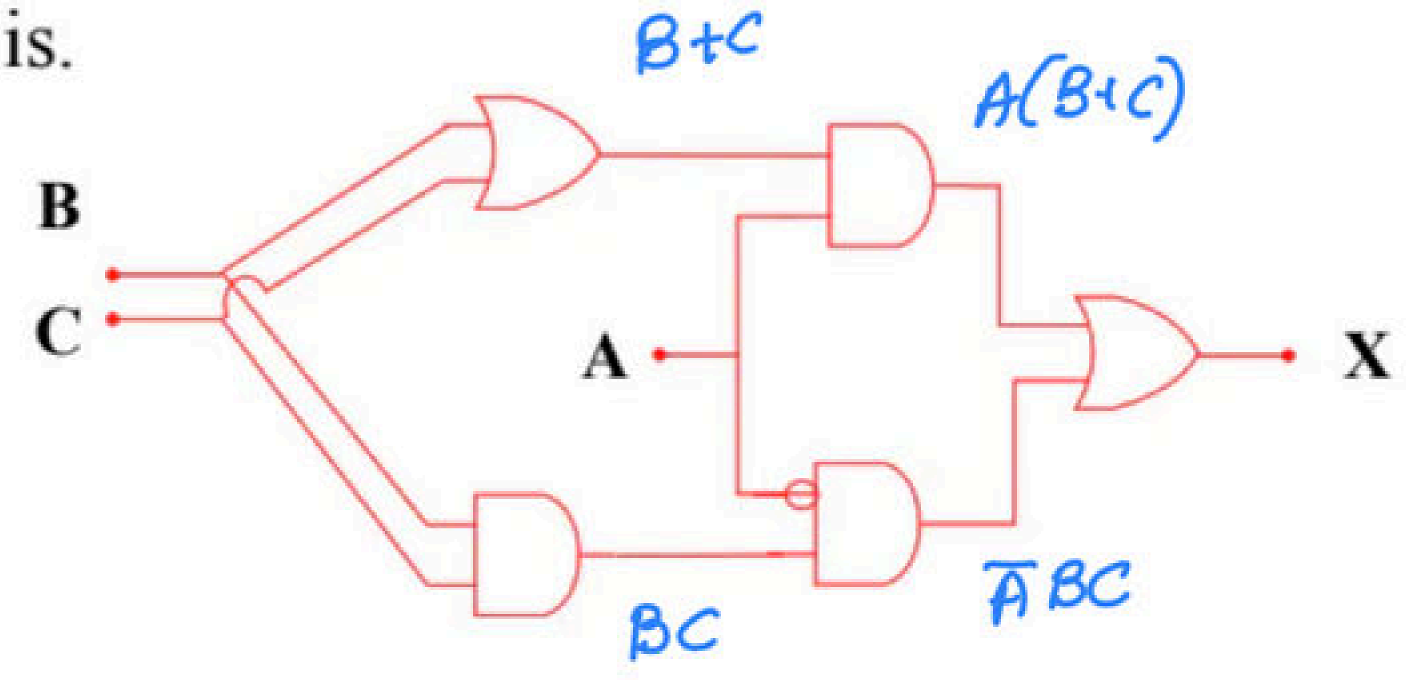
$$Y = \overline{\bar{P}\bar{Q} \cdot \overline{\bar{R}\bar{S}}}$$

$$\boxed{Y = P+Q+R+S}$$

14. In the logic circuit shown in figure, The output x is.

(a) $A\bar{B} + B\bar{C} + C\bar{A}$ (b) $A + B + C$

(c) $AB + BC + CA$ (d) $\overline{AB} + \overline{BC} + \overline{CA}$



$$X = AB + AC + \bar{A}BC$$

$$X = AB + C\left[A + \bar{A}B\right]$$

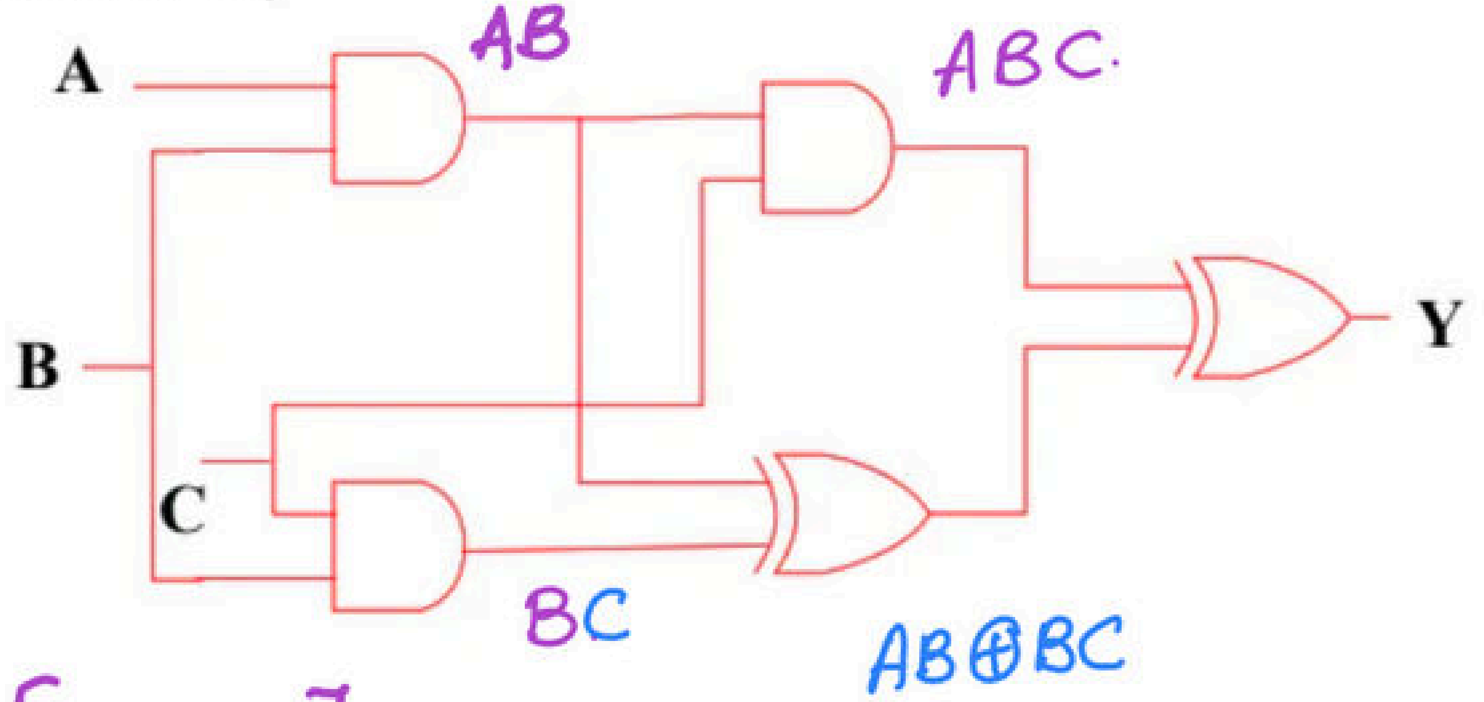
$$X = AB + C\left[A + B\right]$$

$$X = AB + BC + AC$$

15. The output of the combinational circuit given below is,

(a) $A + B + C$ (b) $A\,(B + C)$

(c) ~~$B\,(C + A)$~~ (d) $C\,(A + B)$



$Y = ABC \oplus AB \oplus BC$

$Y = AB[C \oplus 1] \oplus BC.$

$Y = AB[\bar{C}] \oplus BC$

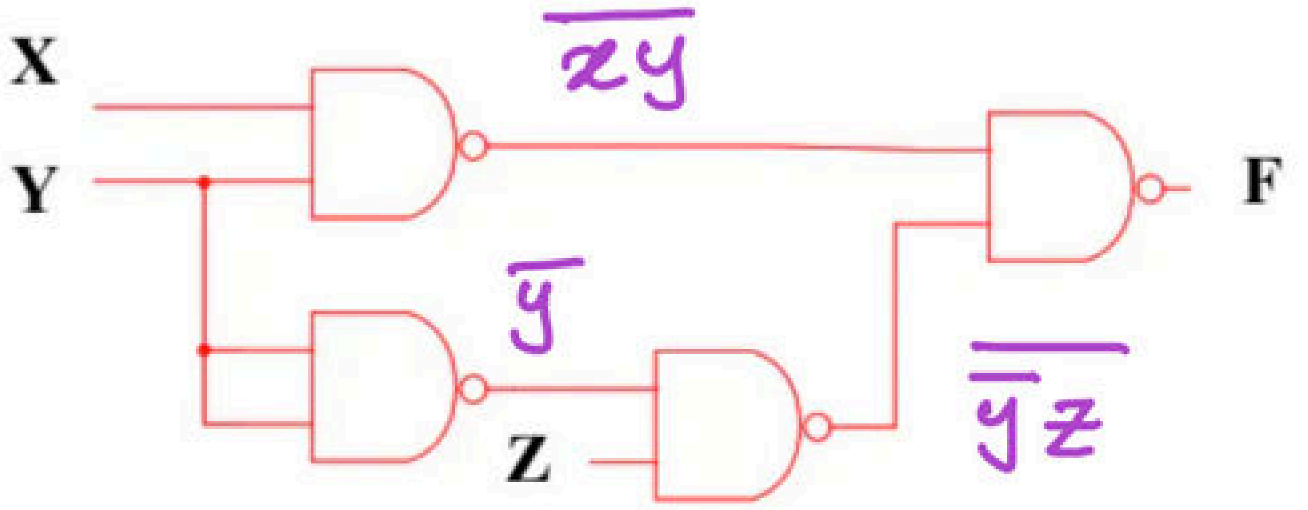
$Y = B[C \oplus A\bar{C}]$

$Y = B[C + A]$

16. In the digital circuit given below, F is

(a) $XY + Y\bar{Z}$ ~~(b)~~ $XY + \bar{Y}Z$

(c) $\overline{XY} + \bar{Y}Z$ (d) $XZ + \bar{Y}$



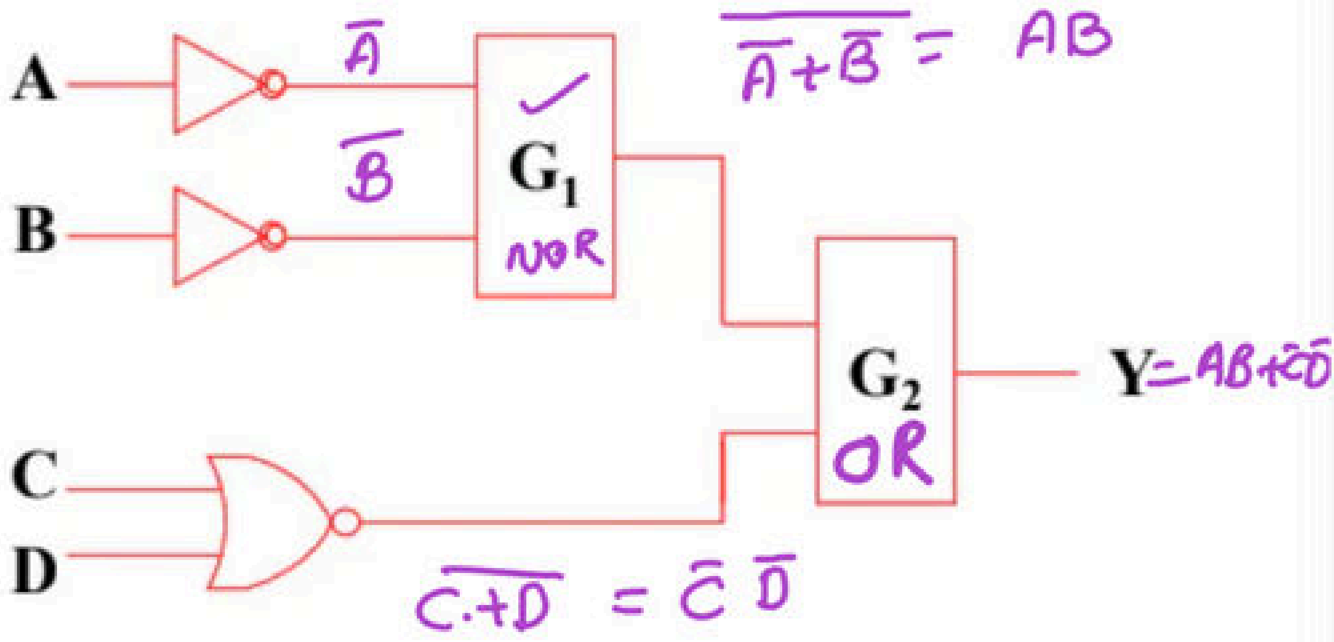
$$F = \overline{\overline{xy} \cdot \overline{\bar{y}z}}$$

$$F = xy + \bar{y}z.$$

17. In the figure shown, the output Y is required to be $Y = AB + \overline{C}\,\overline{D}$. The gates G1 and G2 must be, respectively,

(a) NOR, OR (b) OR, NAND

(c) OR, NAND (d) AND, NAND

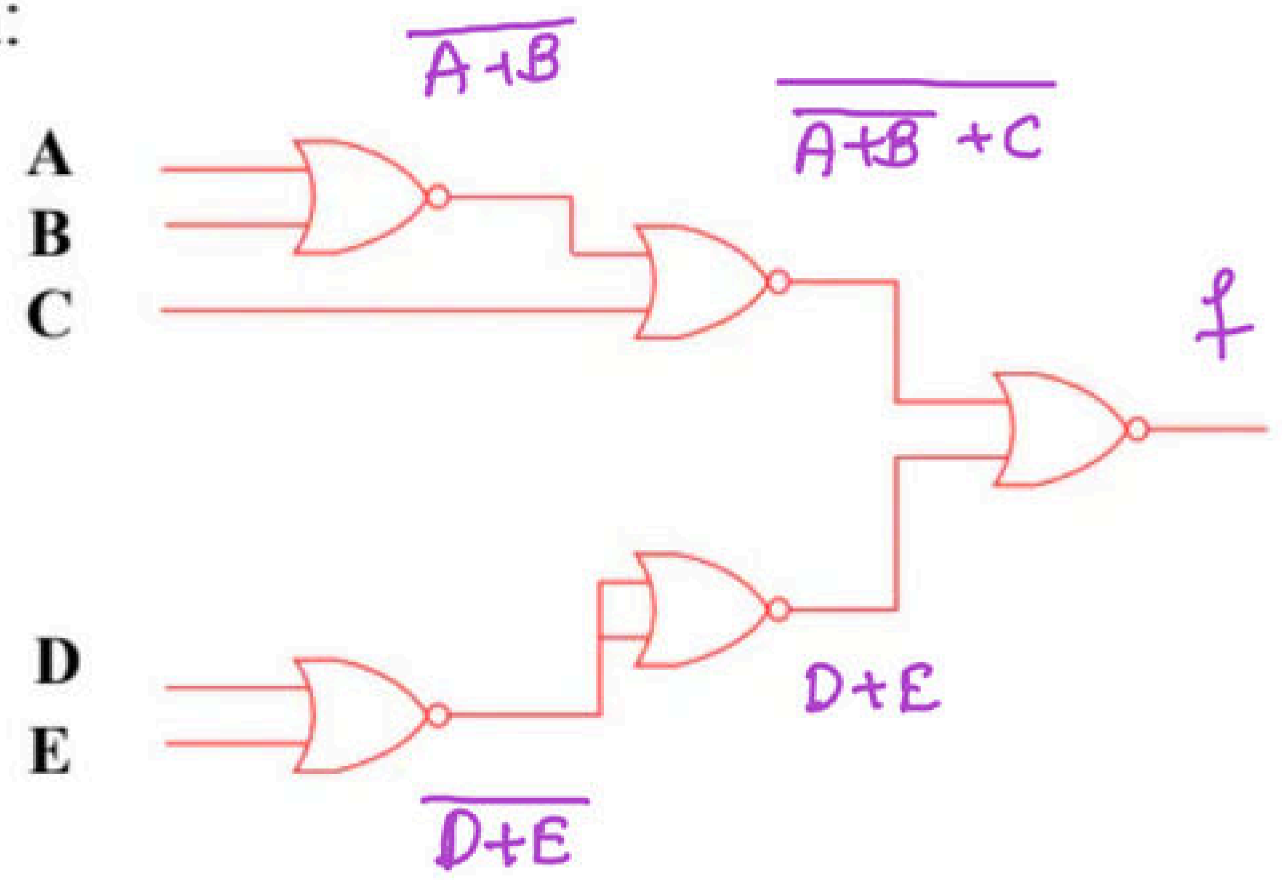


$\boxed{Y = AB + \overline{C}\,\overline{D}}$

18. The circuit shown in the figure realizes the function:

(a) $(A+B+C)(D\overline{E})$ (b) $(A+\overline{(B+C)}(\overline{D}E))$

(c) $(A+B+C)(\overline{D}\,\overline{E})$ ~~(d)~~ $(\overline{A+B}+C)(\overline{D}\,\overline{E})$



$$f = \overline{\overline{\overline{A+B}+C} + D+E}$$

$$f = (\overline{A+B}+C)(\overline{D}\cdot\overline{E})$$

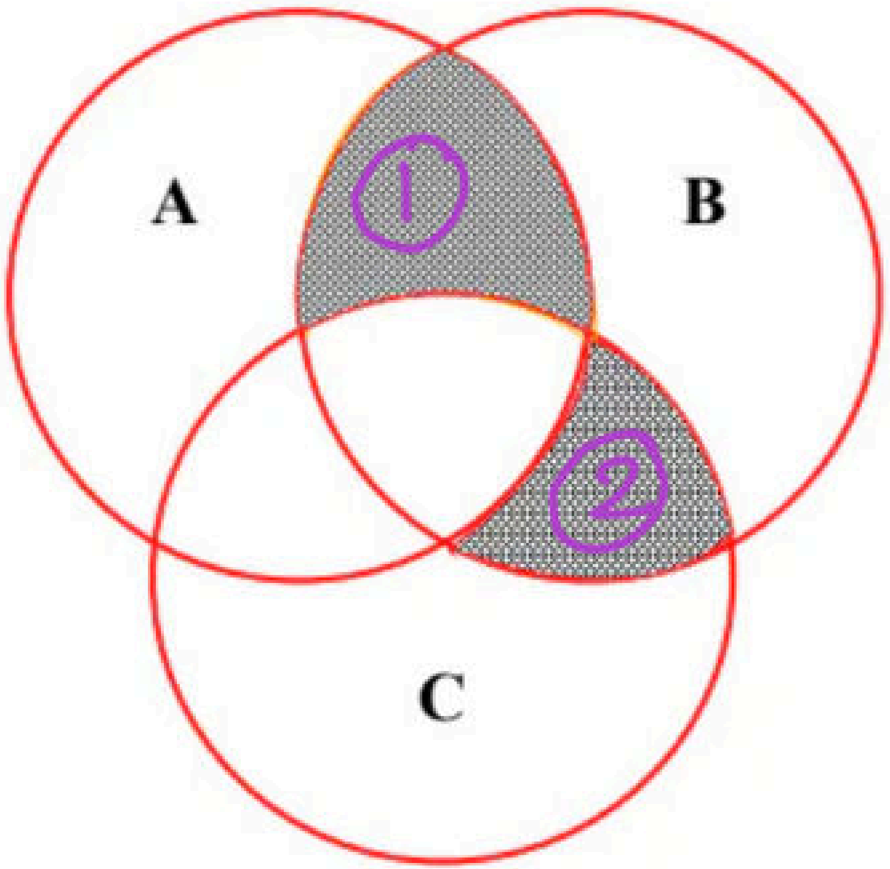
19. The expression for shaded area shown below is:

(a) AB+BC

(b) $\overline{A}\,\overline{B}\,C + A\,\overline{B}\,\overline{C}$

~~(c)~~ $\cancel{AB\overline{C}+\overline{A}\,BC}$

(d) None of the above



$f = AB\overline{C} + \overline{A}BC$

20. The number of Boolean functions which can be generated with four variables is?

(a) 4 (b) 16

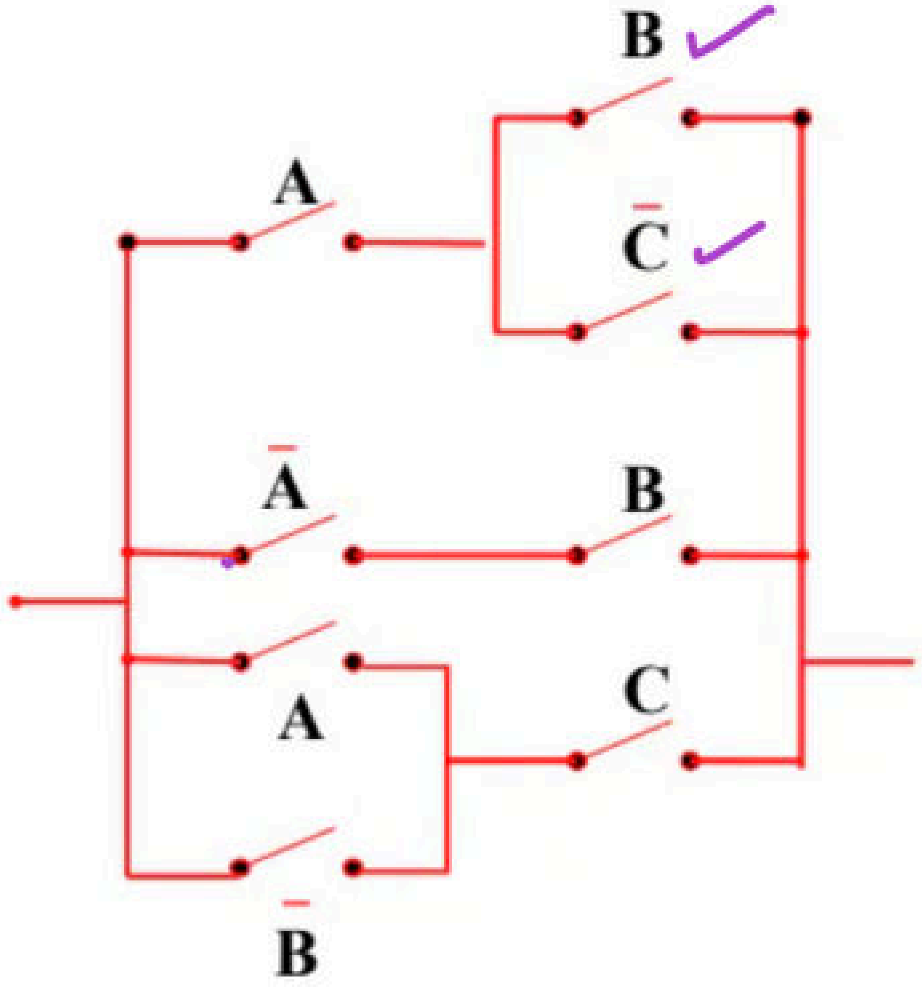
(c) 256 (d) 65,536

$$2^{2^n} = 2^{2^4} = 2^{16} = 2^{10} \cdot 2^{6}$$

$$= (1024)(64)$$

$$= \underline{\underline{65,536}}$$

21. The minimum Boolean for the following circuit is.



(a) AB+AC+BC (b) A+BC

(c)A+B (d) A+B+C

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

$$f = AB + A\bar{C} + \bar{A}B + AC + \bar{B}C$$

$$f = B + A + \bar{B}C$$

$$\boxed{f = A + B + C}$$

22. The Number of switching functions of 3 variables is

(a) 8 (b) 64

(c) 128 ~~(d) 256~~

$$2^{2^{n}} = 2^{2^{3}} = 2^{8} = 256.$$

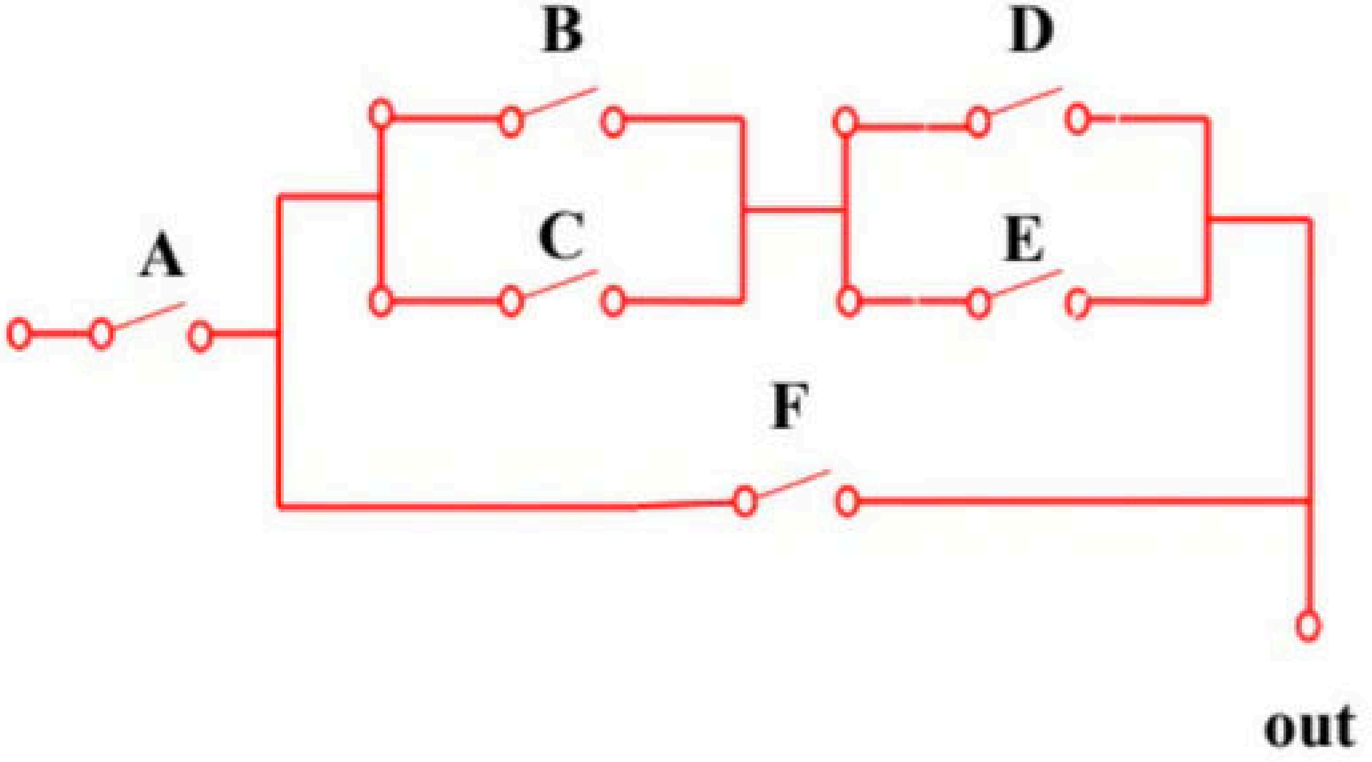
23. What Boolean function does the following circuit represents:

(a) A[F+(B+C) (D+E)]

(b) A[F+(B+C) (DE)]

(c) A[F+(BC) + (DE)]

(d) A[F(B+C) + (D+E)]

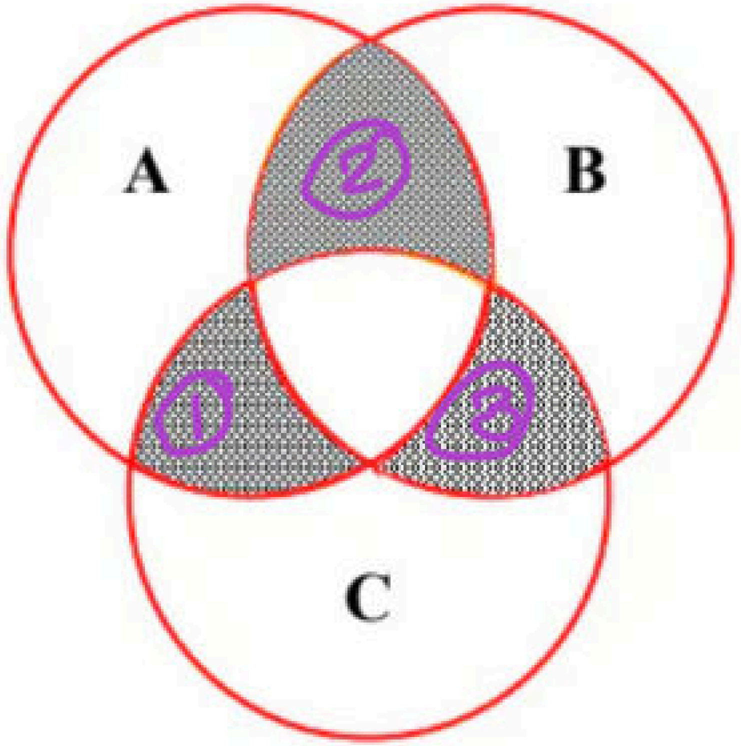


$$y = A \cdot \left[(B+C)(D+E) + F \right]$$

24. The Boolean expression for the shaded area in the given Venn diagram is:

(a) $AB+BC+CA$ (b) $AB\overline{C}+\overline{A}BC+A\overline{B}C$

(c) $ABC+\overline{A}\,\overline{B}\,\overline{C}$ (d) $A\overline{B}\,\overline{C}+A\overline{B}\,\overline{C}$



$f = A\overline{B}C + AB\overline{C} + \overline{A}BC.$

25. In a digital system there are three inputs A, B and C. The output should be high when at-least two inputs are high, the Boolean expression for the output is.

(MSQ)

~~(a) $AB+BC+AC$~~

~~(b) $ABC+AB\overline{C}+\overline{A}CB+A\overline{B}C$~~

(c) $AB\overline{C}+A\overline{B}C+\overline{A}BC$

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

$Y = \sum m(3, 5, 6, 7)$

26. A bulb in a staircase has two switches, one switch being at the ground floor and the other one at the first floor. The bulb can be turned ON and also can be turned OFF by any one of the switches irrespective of the state of the other switch. The logic of switching of the bulb resembles

(a) an AND gate (b) an OR gate

(c) an XOR gate (d) a NAND gate

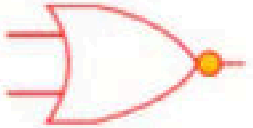
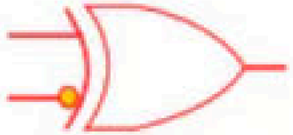
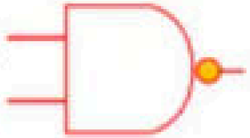
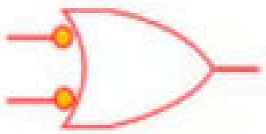
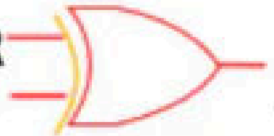
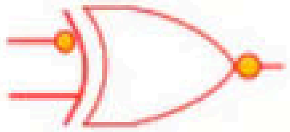
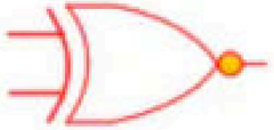
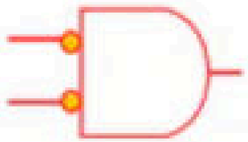
Staircase Switch

Two-way Switch.

A	B	Y
off	off	off
off	on	on
on	off	on
on	on	off.

XOR

27. Match the logic gates in Column A with their equivalents in Column B.

Column A	**Column B**
P  4	1 
Q  2	2 
R  3	3 
S  1	4 

(a) P-2, Q-4, R-1, S-3 (b) P-4, Q-2, R-1, S-3

(c) P-2, Q-4, R-3, S-1 ~~(d) P-4~~, Q-2, R-3, S-1

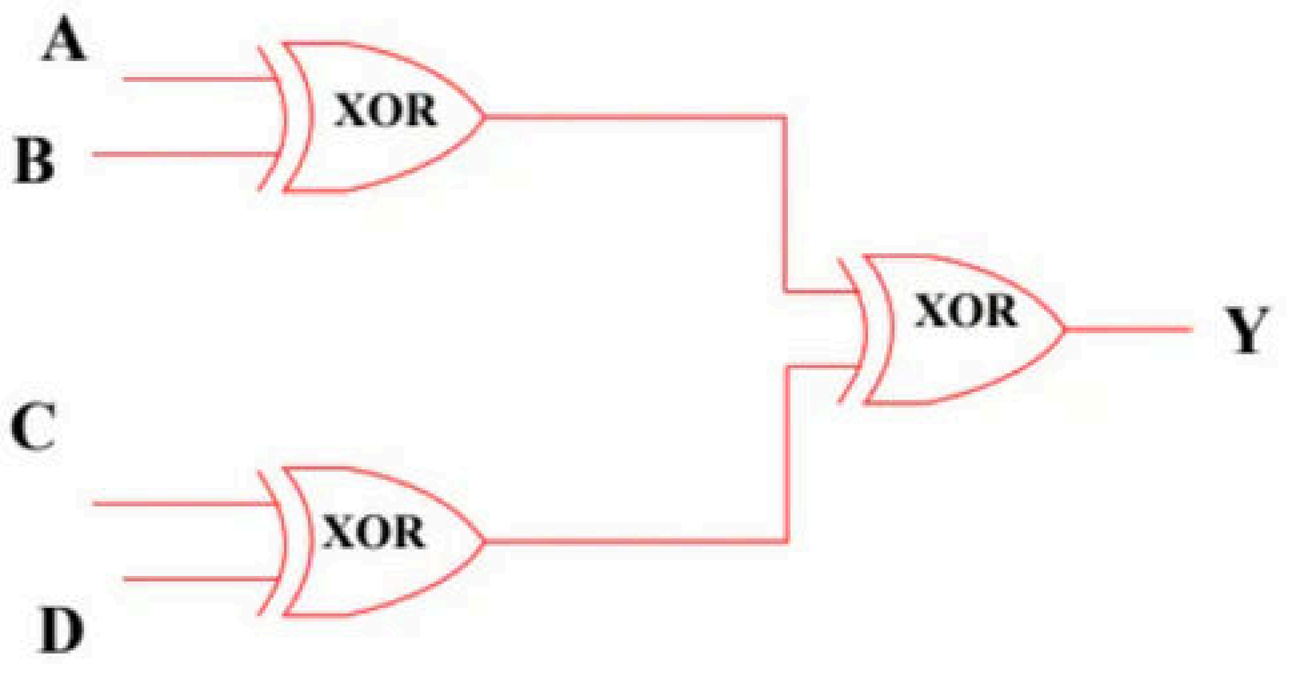
28. A, B, C and D are input bits, and Y is the output bit in the XOR gate circuit of the figure below. Which of the following statements about the sum S of A, B, C, D and Y is correct?

(a) S is always either zero or odd

(b) ~~S is~~ always either zero or even

(c) S = 1 only if the sum of A, B, C and D is even

(d) S = 1 only if the sum of A, B, C and D is odd



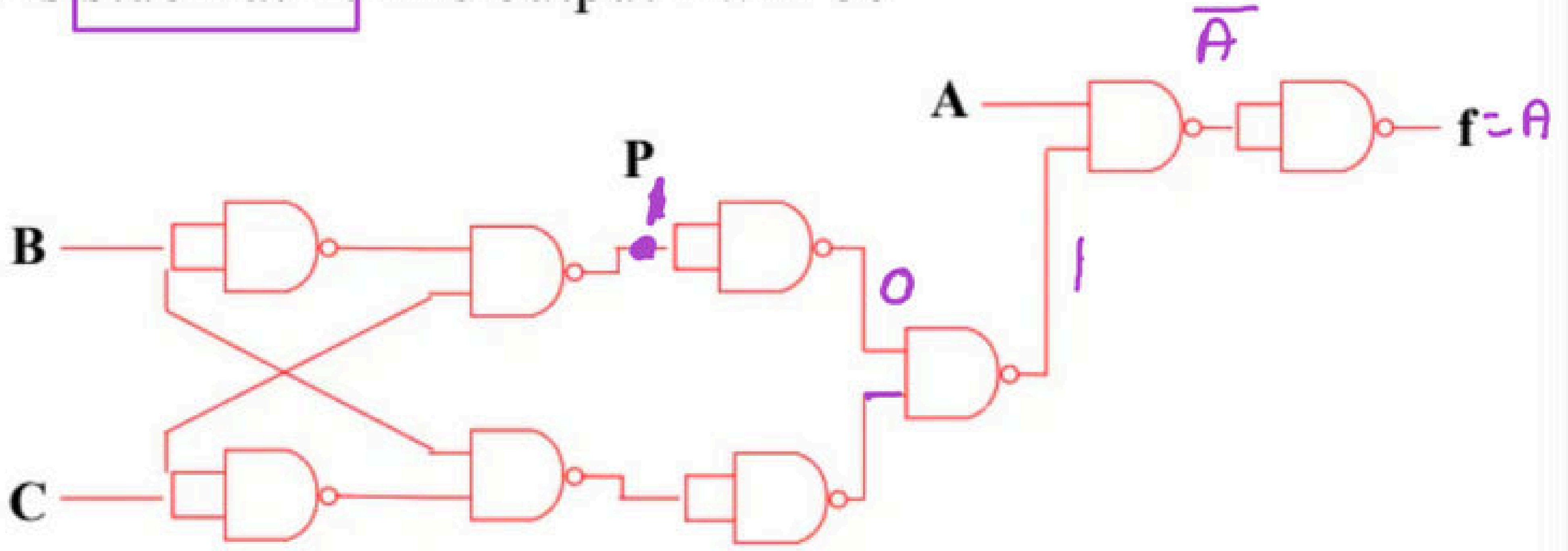
$$\boxed{Y = A \oplus B \oplus C \oplus D}$$

A	B	C	D	Y	S = A+B+C+D+Y
0	0	0	0	0	S = 0
0	0	0	1	Y = 1	S = 2
0	0	1	0		
0	1	0	0		
1	0	0	0		
0	0	1	1	Y = 0	S = 2.
0	1	1	1	Y = 1	S = 4
1	1	1	1	Y = 0	S = 4

29. The point P in the following figure is stuck-at-1. The output f will be

(a) $\overline{AB\overline{C}}$ (b) $\overline{A}$

(c) $AB\overline{C}$ ~~(d)~~ A

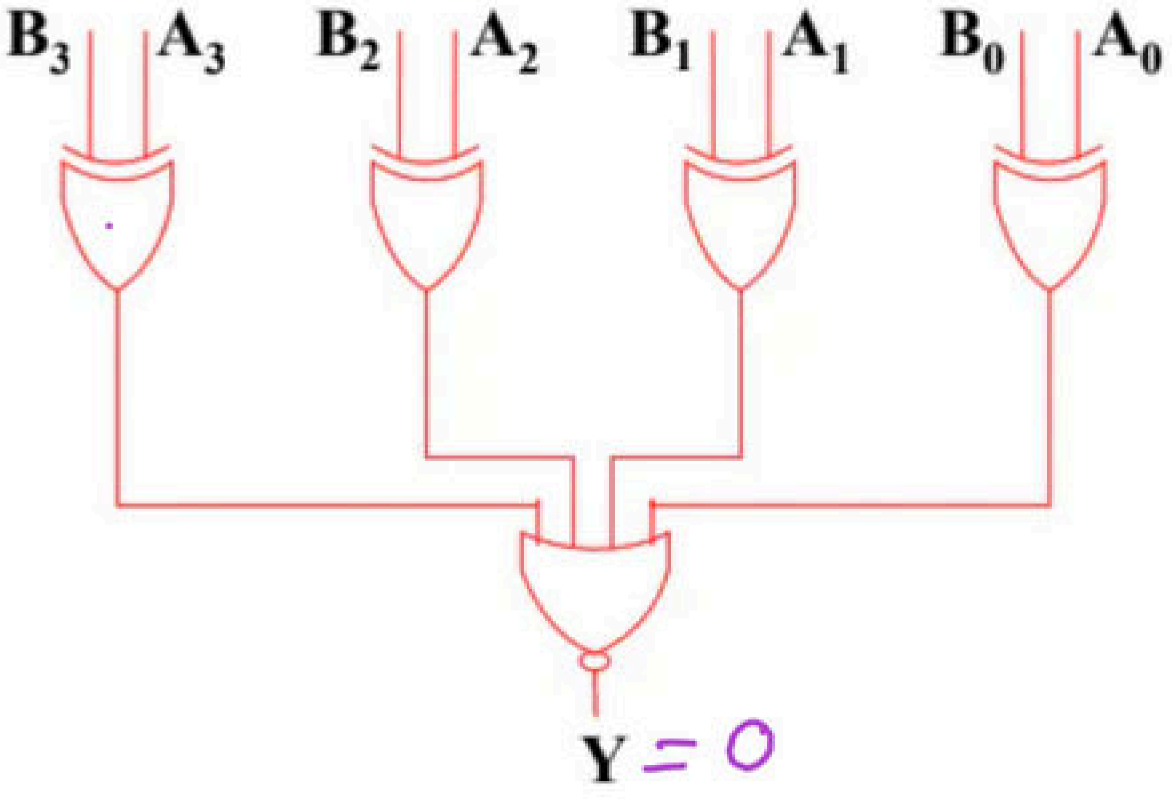


Stuck at 0

30. A digital circuit, which compares two numbers, $A_3, A_2, A_1, A_0, B_3\ B_2\ B_1\ B_0$ is shown in figure. To get output $Y = 0$, choose one pair of correct input numbers.

(a) ~~1010, 1010~~ (b) 0101, 0101

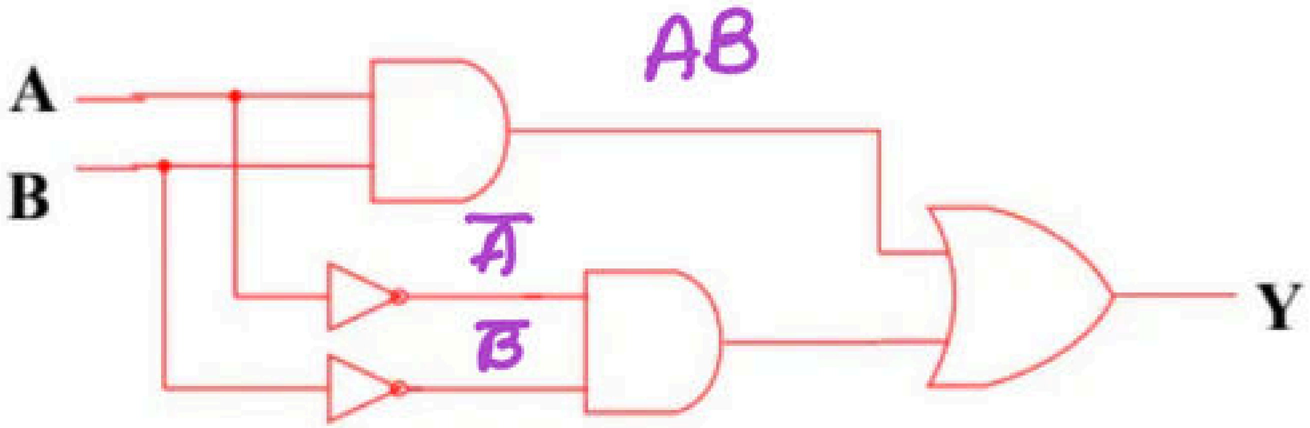
(c) 0010, 0010 (d) 0010, 1011



31. The logic circuit of figure is a

(a) Half adder (b) XOR

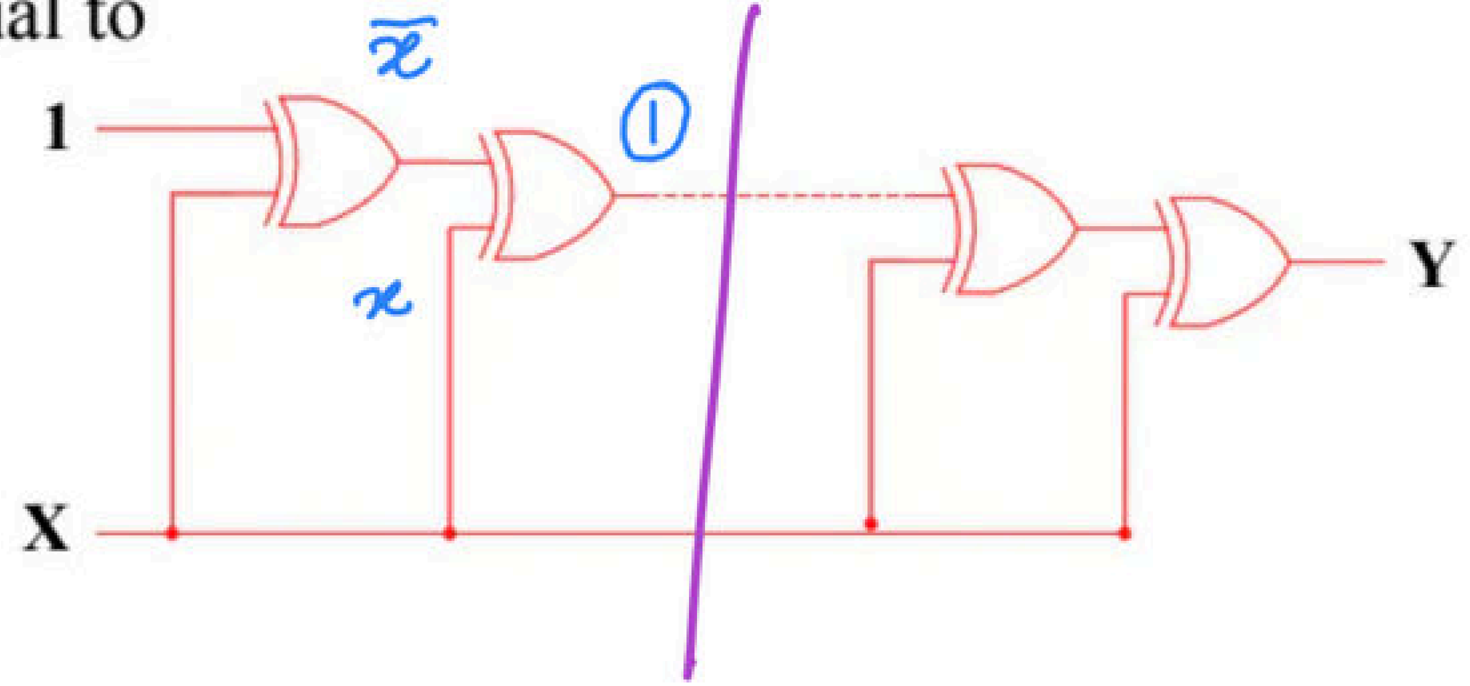
(c) Equality detector (d) Full adder



$y = AB + \bar{A}\bar{B}$

X NOR

32. If the input to the digital circuit (shown in the given figure) consisting of a cascade of 20 XOR-gates is X, then the output Y is equal to



(a) 0 (b) 1

(c) $\bar{X}$ (d) X

$n = 2$

33. The output of a logic gate is "1" when all its inputs are at logic "0". The gate is either

(a) A NAND or EX-OR gate

(b) A NOR or an EX-OR gate

(c) An AND or an EX-OR gate

(d) A NOR or an EX-NOR gate

A	B	Y
0	0	1

→ NAND

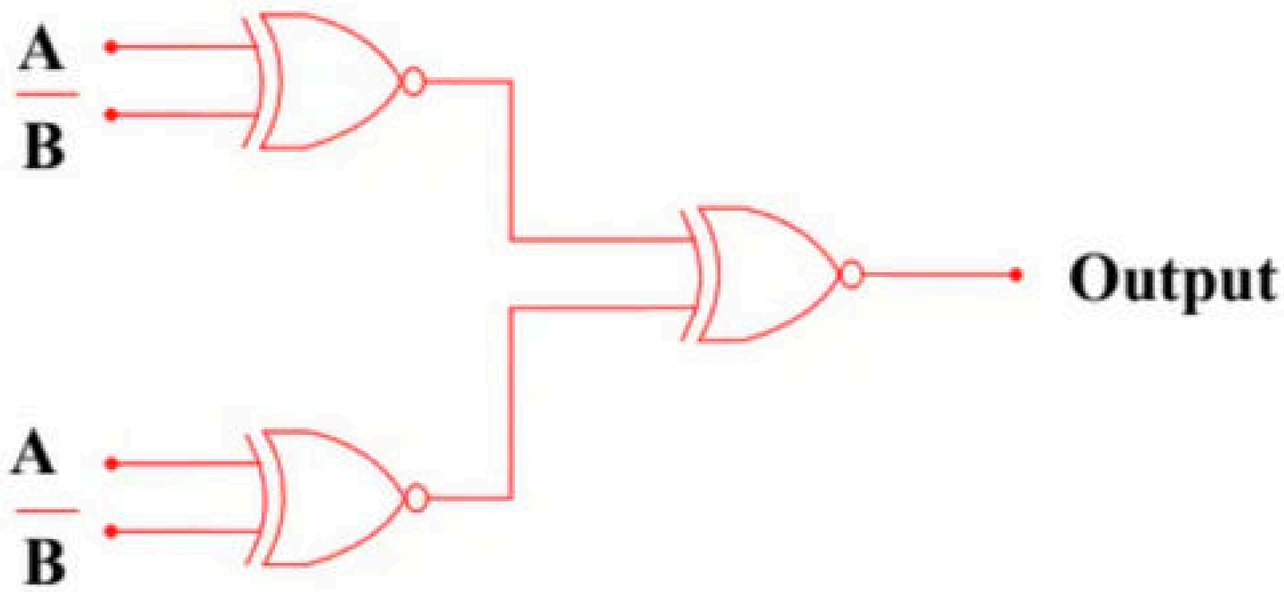
→ NOR

→ EX-NOR.

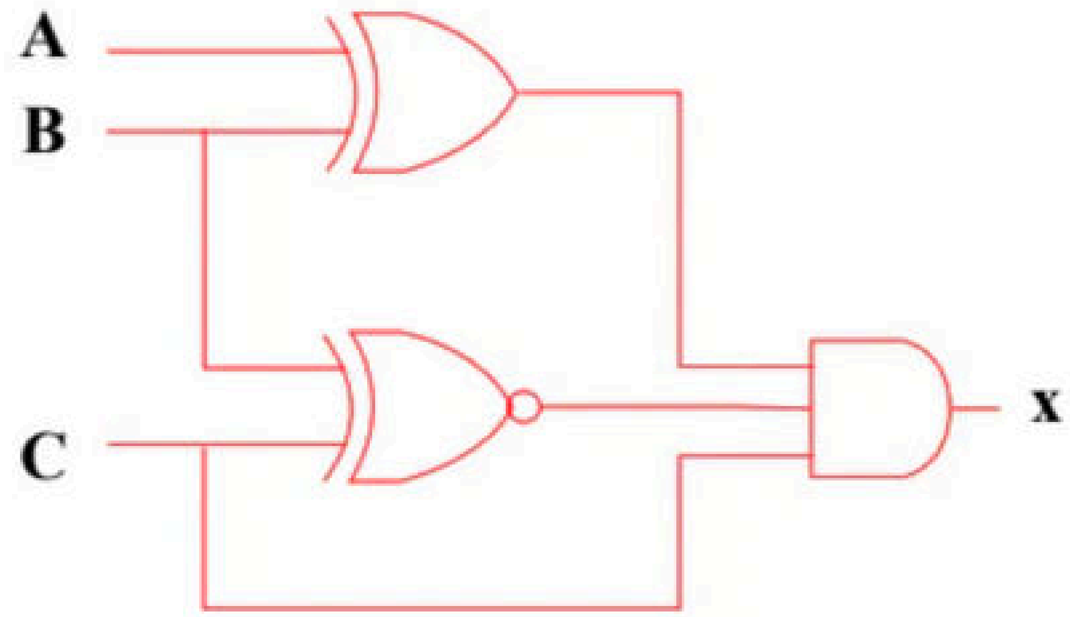
34. The output of the circuit shown (in figure) is equal to

(a) 0 (b) 1

(c) $\overline{A}B + A\overline{B}$ (d) $(\overline{A * B}) * (\overline{A * B})$



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



(a) 1, 0, 1 (b) 0, 0, 1

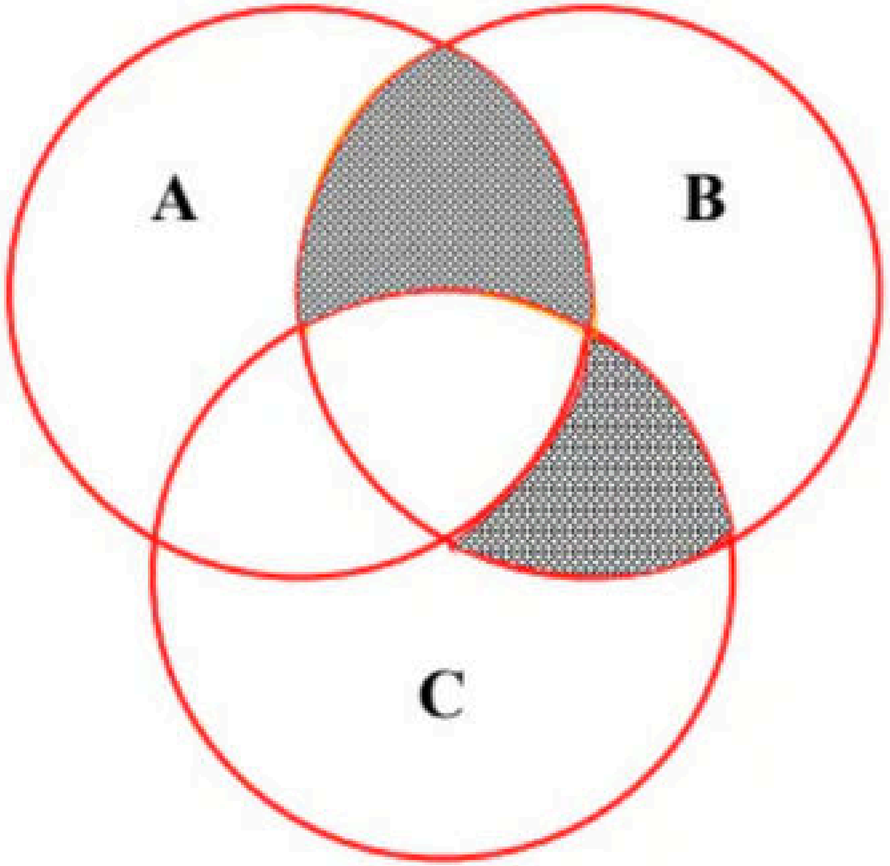
(c) 1, 1, 1 (d) 0, 1, 1

36. The operation $x \oplus \overline{y}$ represents:

(a) $x - y$ (b) $\overline{x}\,y + \overline{xy}$

(c) $x\,y + \overline{x}\,\overline{y}$ (d) $x - \overline{y}$

37. The expression for shaded area shown below is:



(a) $AB+BC$

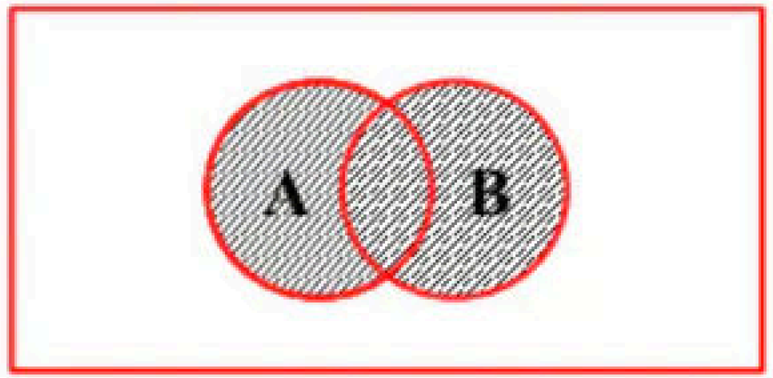
(b) $\overline{A}\,\overline{B}\,C + A\,\overline{B}\,\overline{C}$

(c) $AB\overline{C}+\overline{A}\,BC$

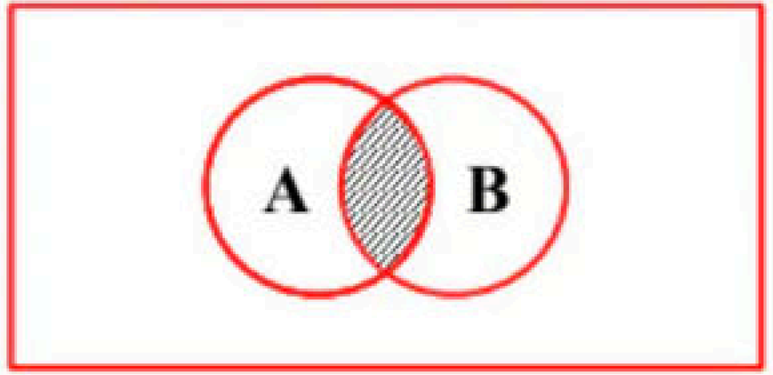
(d) None of the above

38. The Venn diagram representing the Boolean expression $(A+\overline{A}.B)$ is.

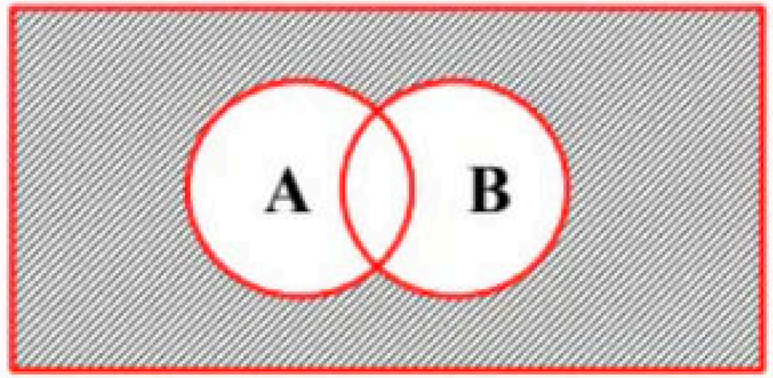
(a)



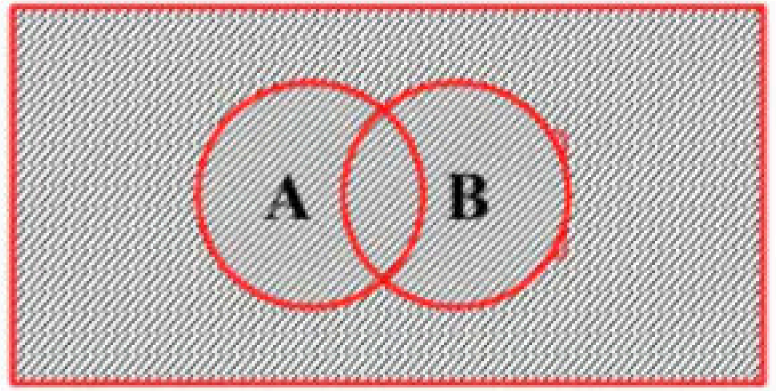
(b)



(c)



(d)



39. Match List-I with List-II and select the correct answer using the codes given below the Lists:

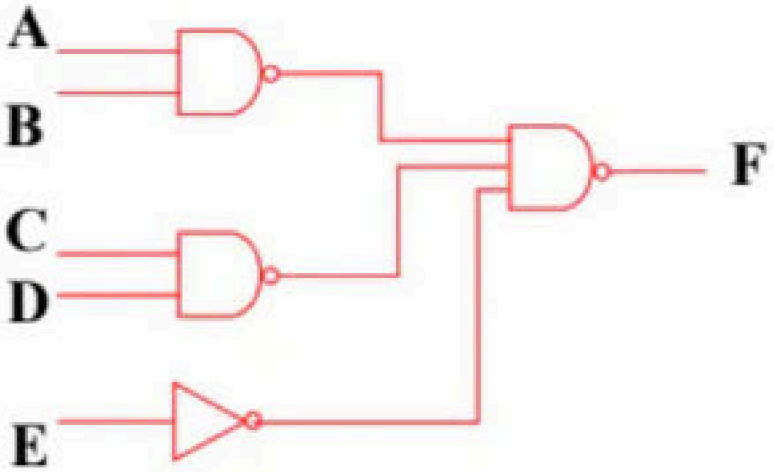
List-I	List-II
A. $A \oplus B = 0$	1. $A \neq B$
B. $\overline{A + B} = 0$	2. $A = B$
C. $\overline{A} . B = 0$	3. A=1 or B=1
D. $A \oplus B = 1$	4. A=1 or B=0

Codes:

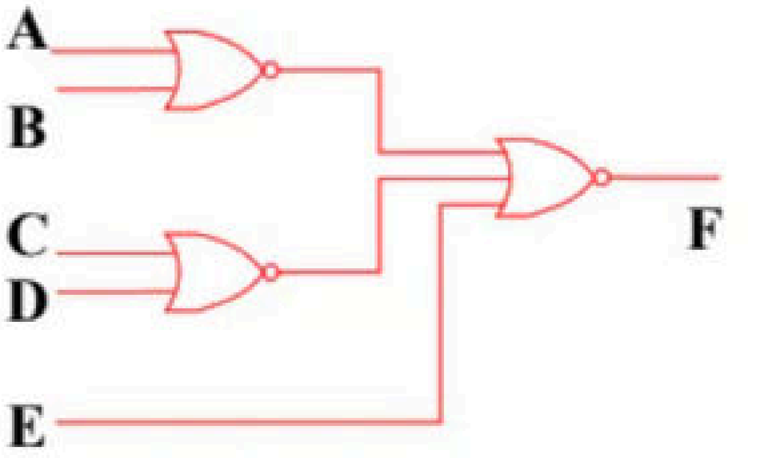
	A	B	C	D
(a)	3	2	1	4
(b)	2	3	4	1
(c)	3	2	4	1
(d)	2	3	1	4

40. The Boolean function F=AB+CD+E can be realized as

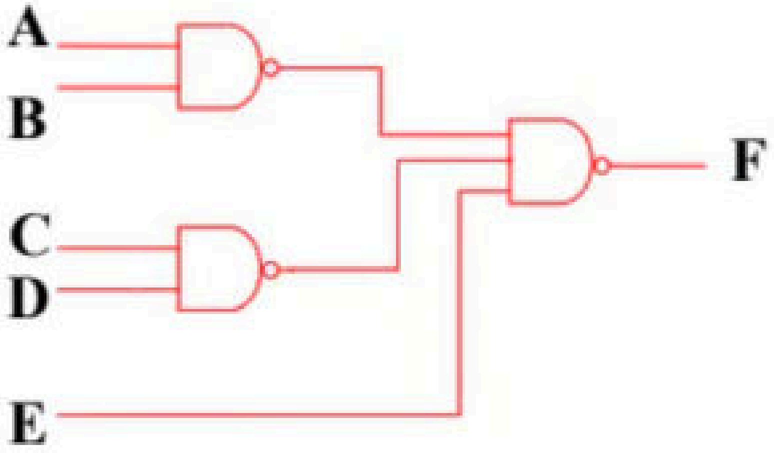
(a)



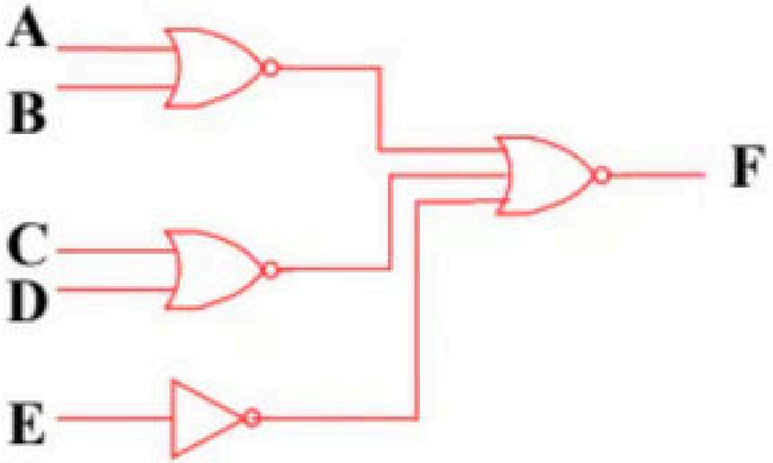
(b)



(c)



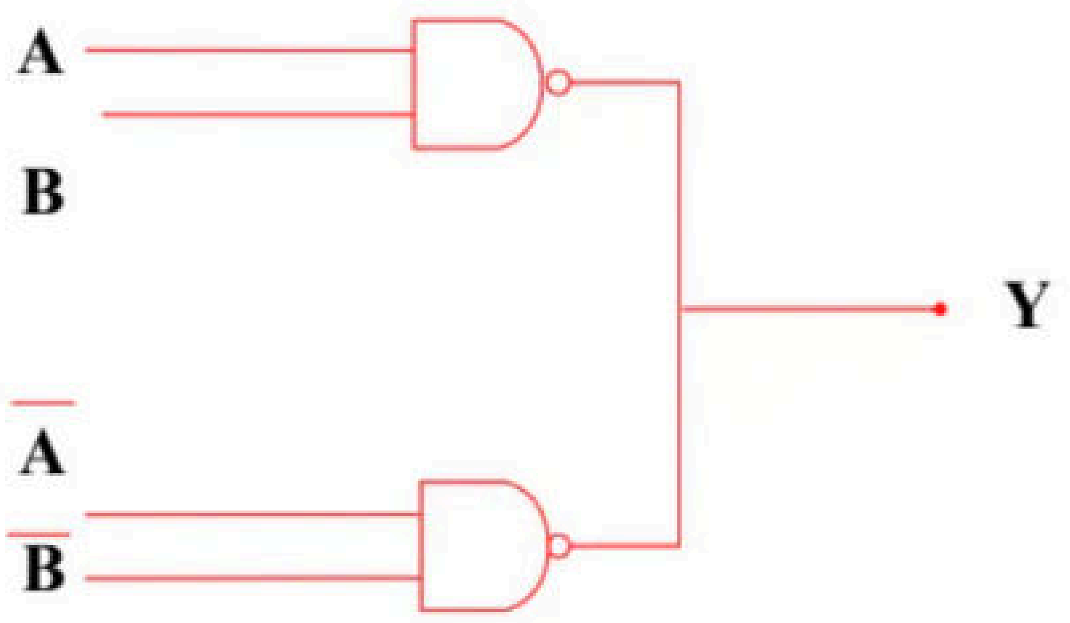
(d)



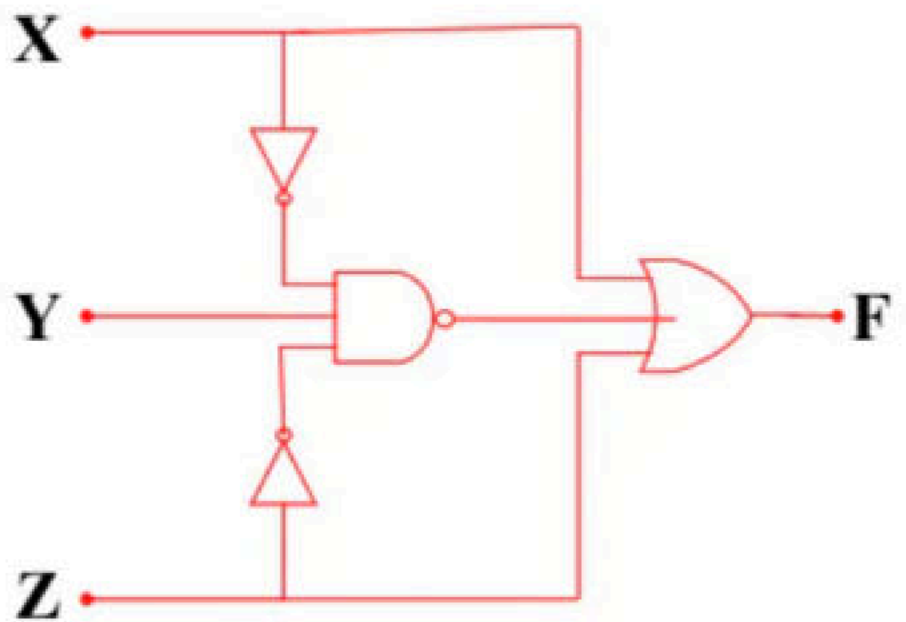
41. The open collector wired circuit shown below functions as:

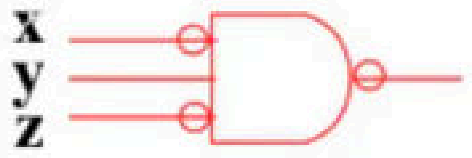
(a) EX – NOR (b) AND

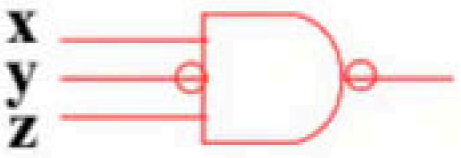
(c) EX – OR (d) NOR

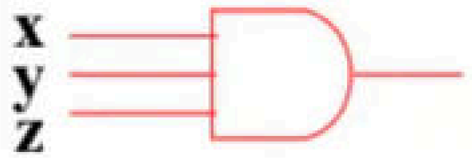


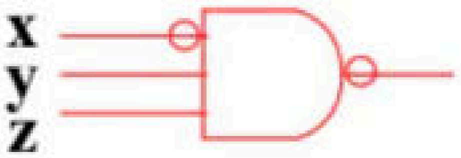
42. The Minimized version for the logic circuit shown in the figure is:



(a) 

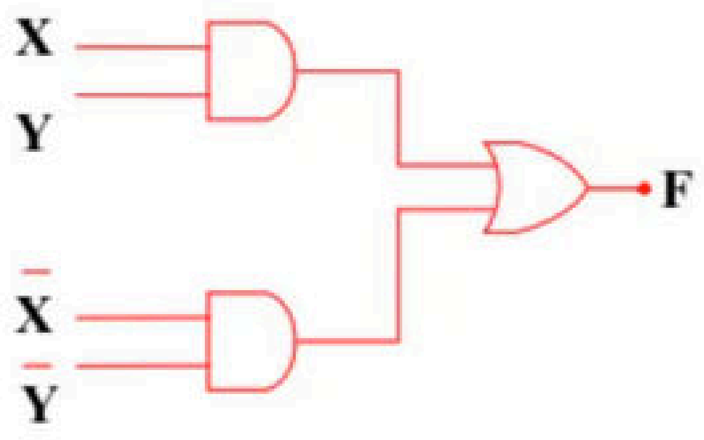
(b) 

(c) 

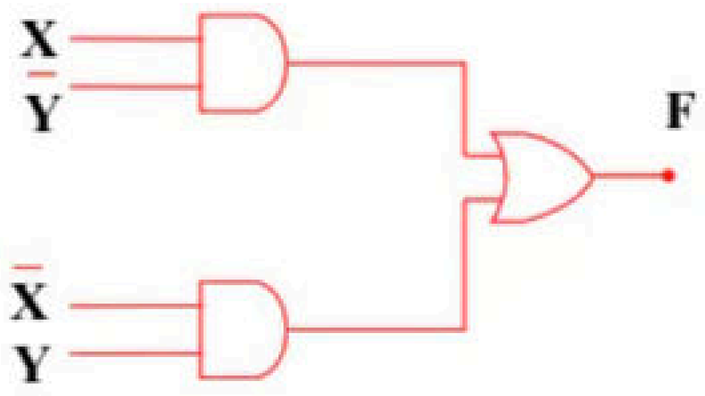
(d) 

43. Which of the following is a coincidence logic circuit:

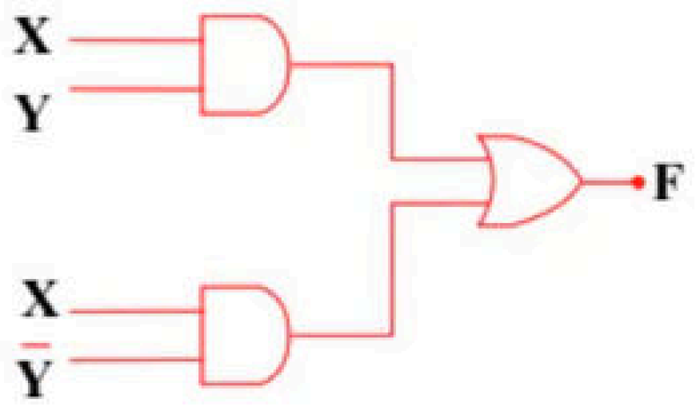
(a)



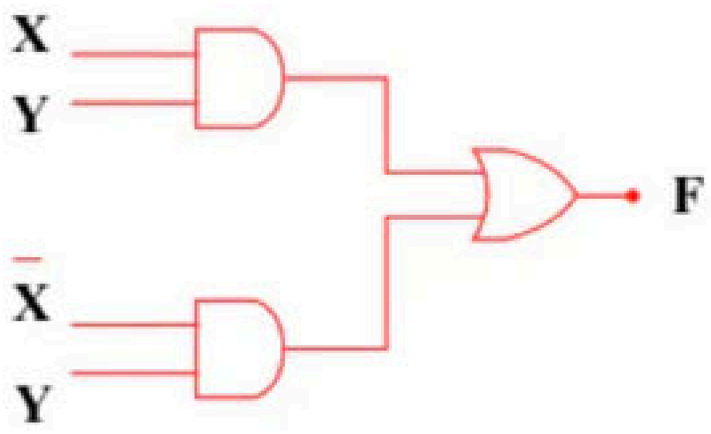
(b)



(c)



(d)



44. The gate whose output is LOW if and only if all the inputs are HIGH, is

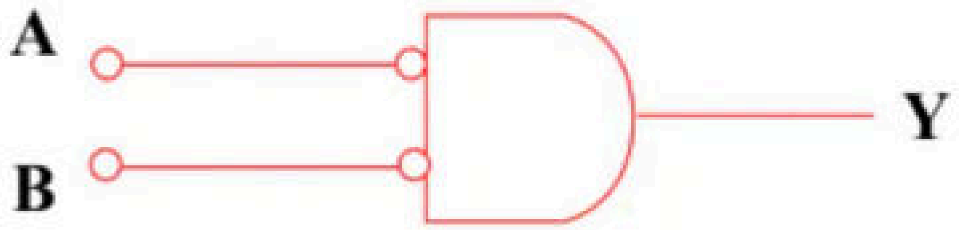
(a)NAND (b) NOR

(c) OR (d) AND

45. The negative logic AND gate shown in the given figure is equivalent to positive logic.

(a) AND gate (b) OR gate

(c) NAND gate (d) NOR gate



46. Which one of the following sets of gates are best suited for parity checking and parity generation?

(a) AND, OR, NOT gates

(b) X-OR, X-NOR gates

(c) NAND gates

(d) NOR gates

47. The output of a logic gate is '1' when all its inputs are at logic '0'. The gate is either.

(a) A NAND or an EX-OR

(b) An OR or an EX-OR

(c) An AND or an EX-OR

(d) A NOR or an EX-NOR

48. A three-input NAND gate is to be used as an inverter. Which one of the following measures will achieve better results?

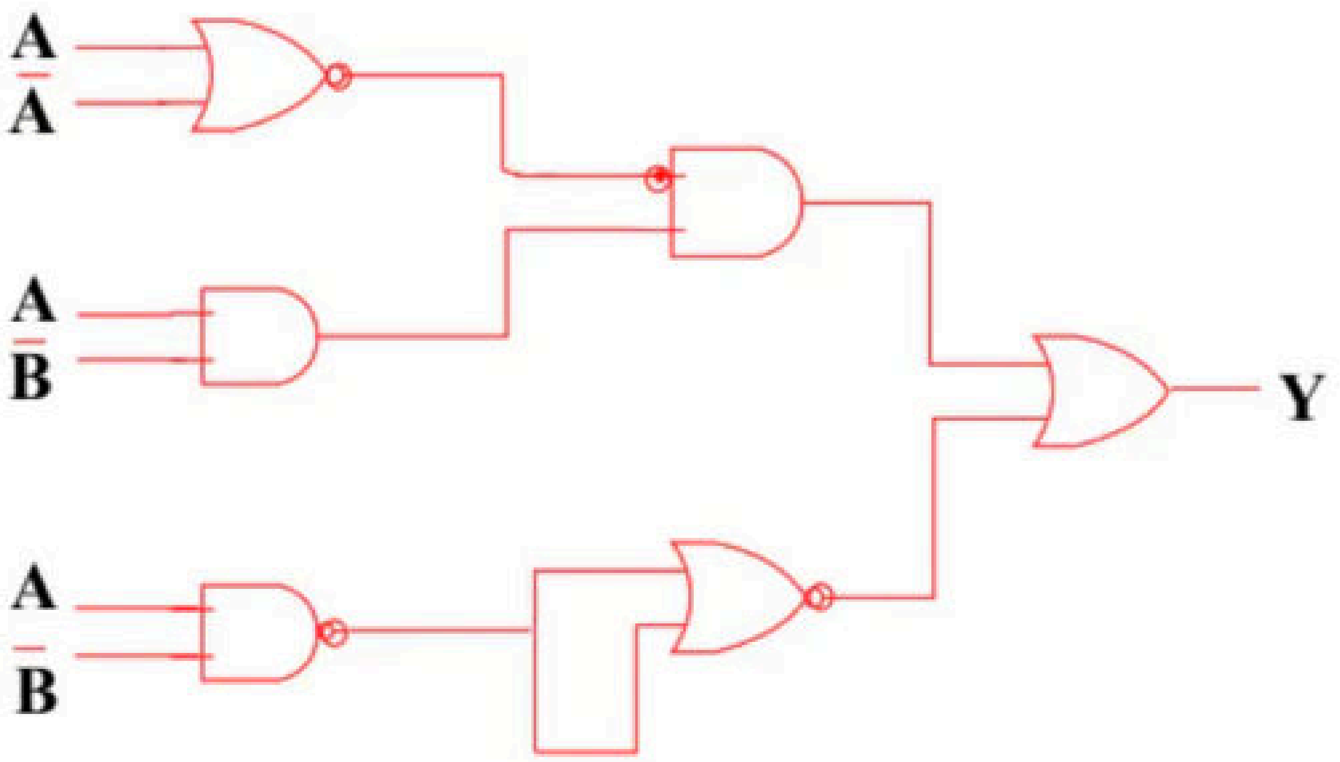
(a) The two inputs not used are kept open

(b) The two inputs not used are connected to ground (0 level)

(c) The two inputs not used are connected to V_{cc}

(d) None of the above

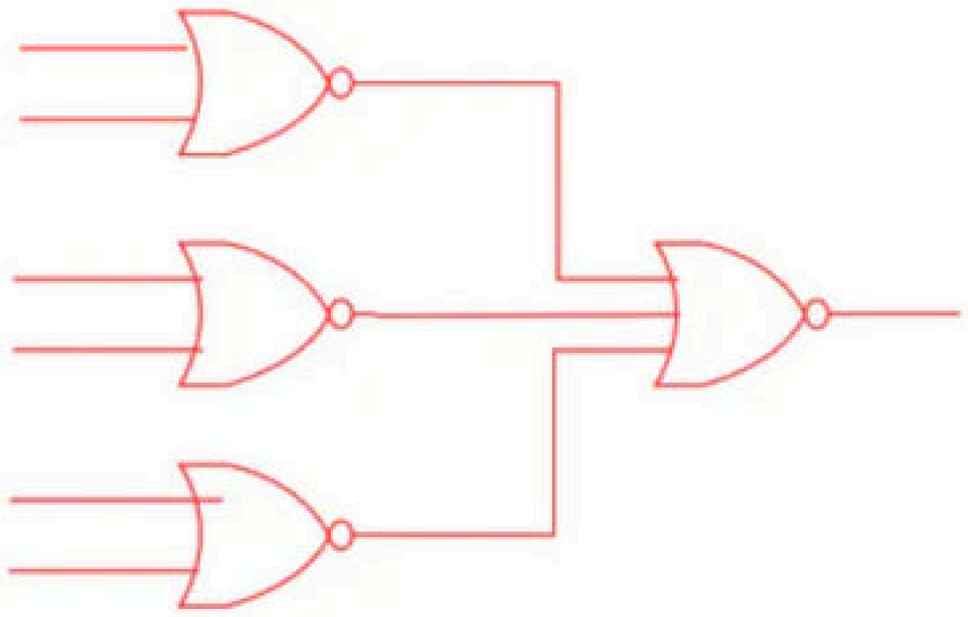
49. The output Y for the logic circuit shown in the given figure is



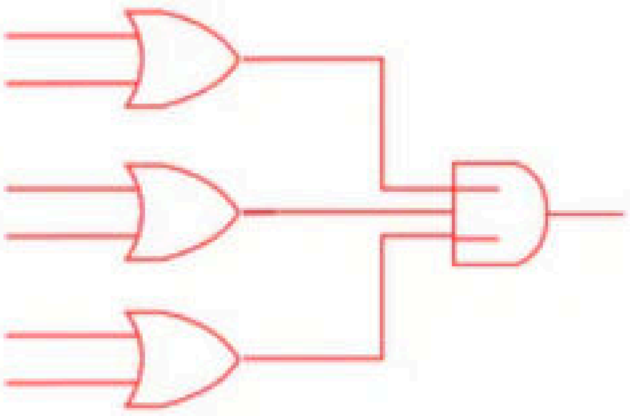
(a) $A\overline{B}$ (b) $\overline{A} + \overline{B}$

(c) $\overline{A}\overline{B}$ (d) $A + \overline{B}$

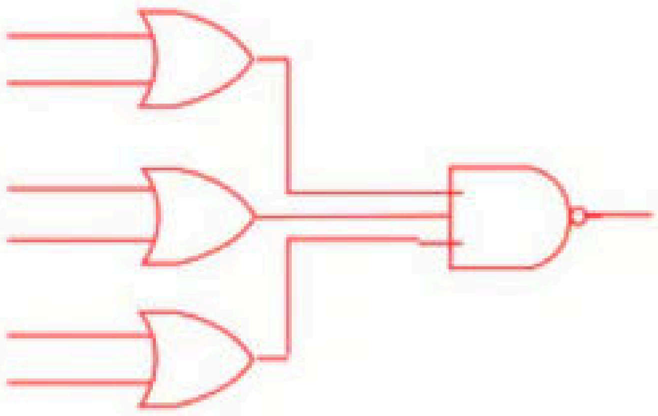
50. The circuit shown in figure is equivalent to:



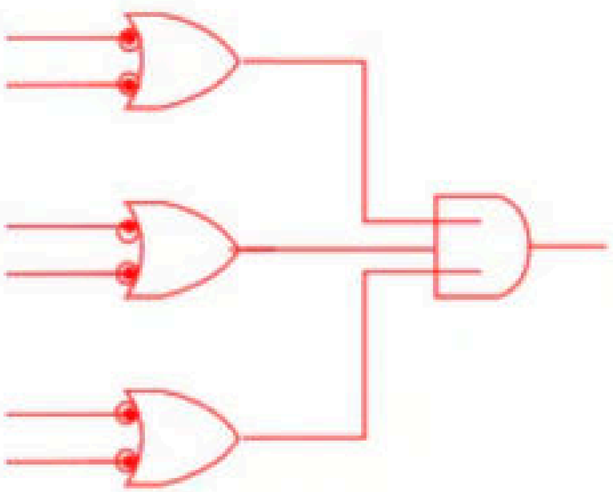
(a)



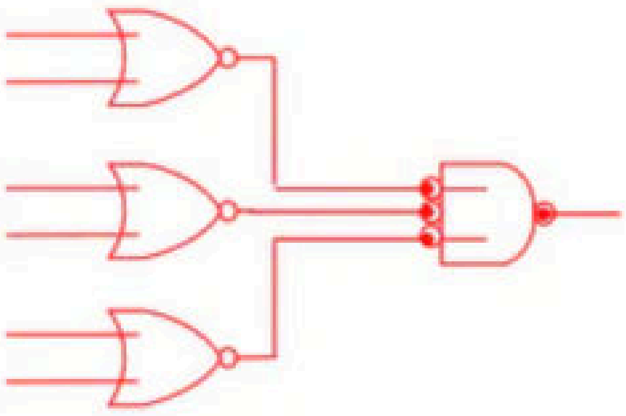
(b)



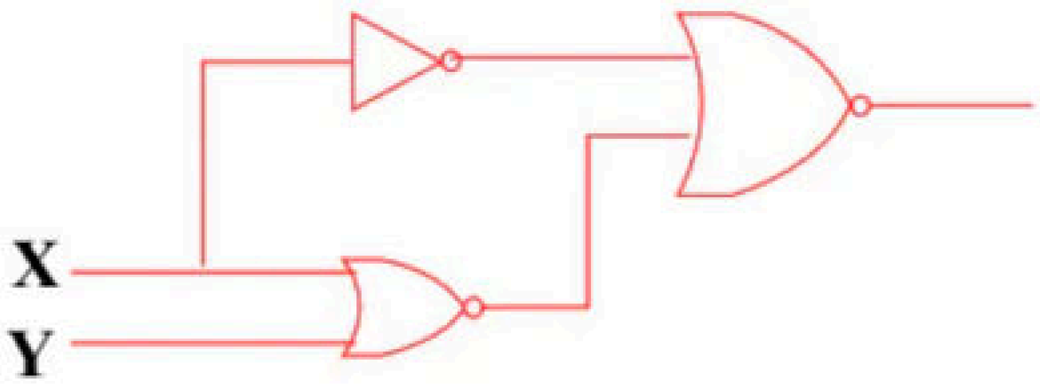
(c)



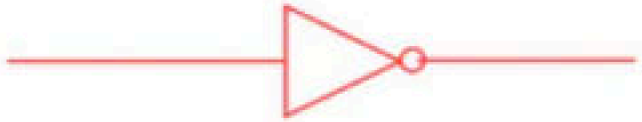
(d)



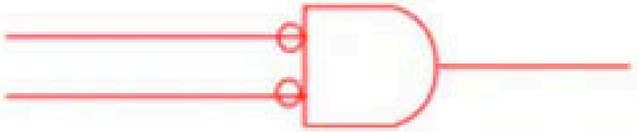
51. The logic circuit shown in the figure can be Minimized to



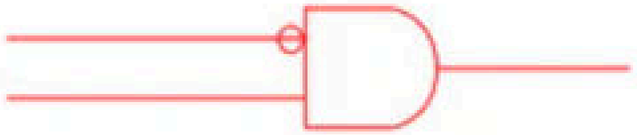
(a)



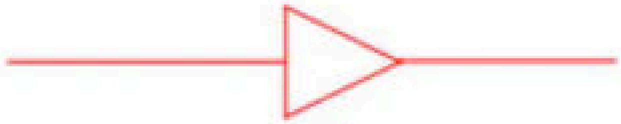
(b)



(c)



(d)



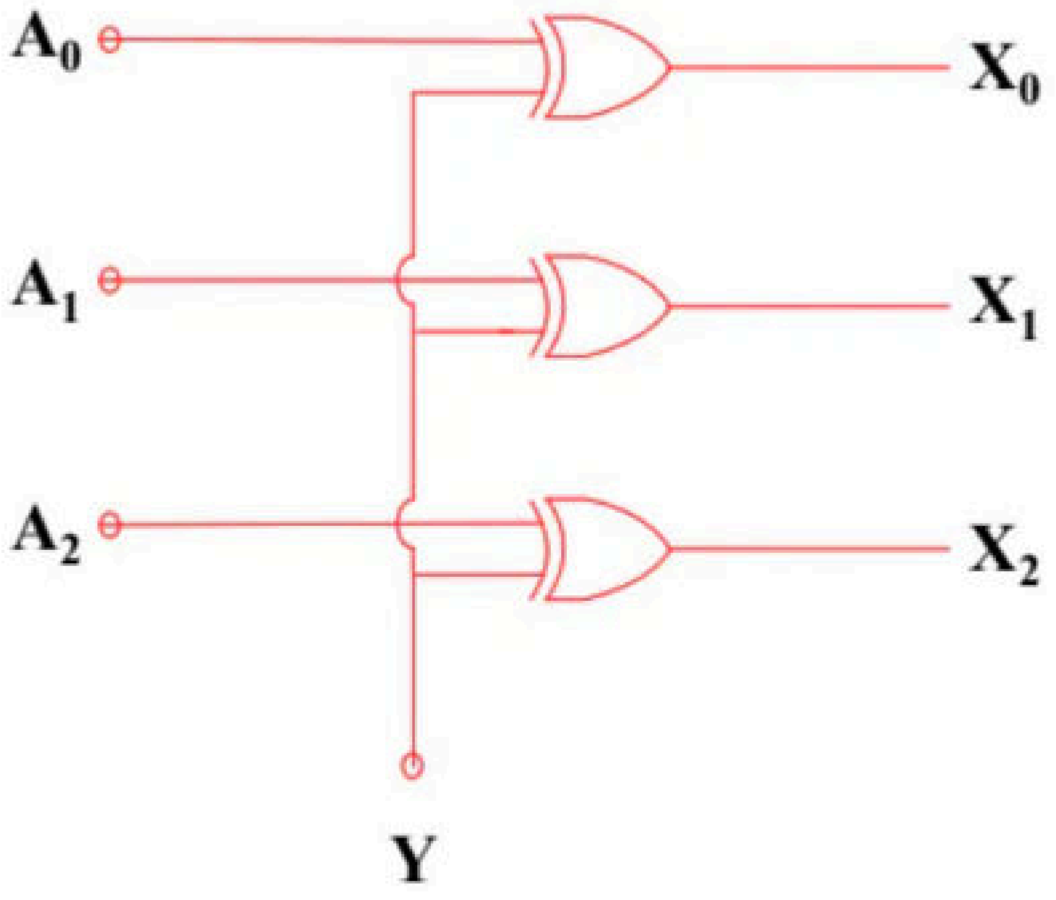
52. In the figure shown, $X_2\ X_1\ X_0$ will be 1's complement of $A_2\ A_1\ A_0$ if

(a) $Y = 0$

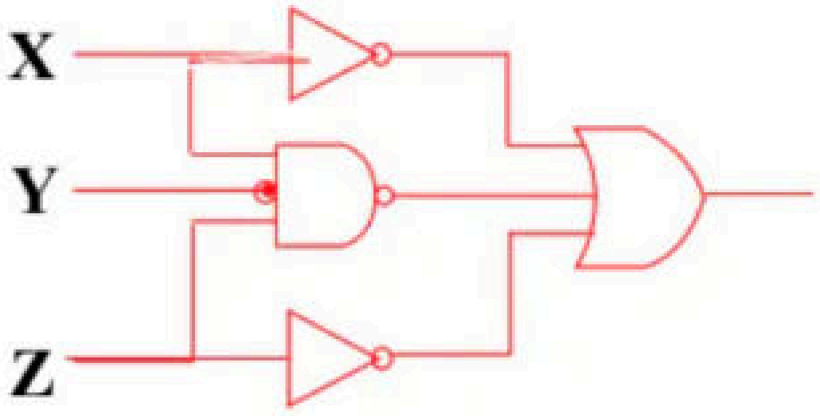
(b) $Y = 1$

(c) $Y = \overline{A}_0 = \overline{A}_1 = \overline{A}_2$

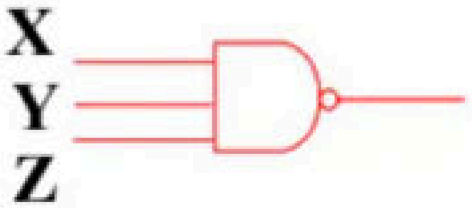
(d) $Y = A_0 = A_1 = A_2$



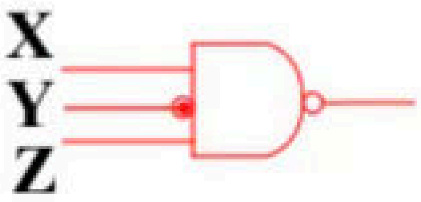
53. The minimized logic circuit for the circuit shown in figure is



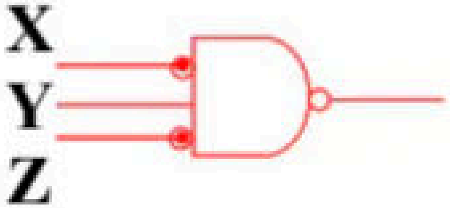
(a)



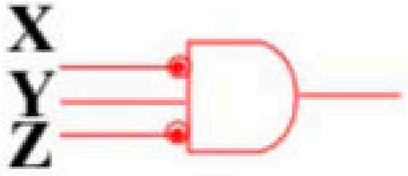
(b)



(c)



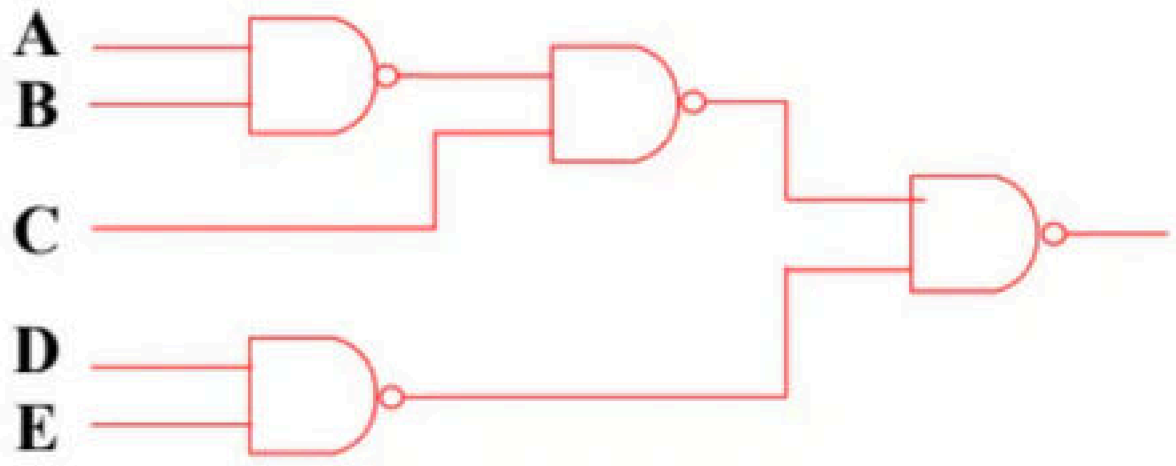
(d)



54. The circuit shown in the following figure realizes the function.

(a) $(\overline{A} + \overline{B})C + DE$ (b) $(A + B)C + D + E$

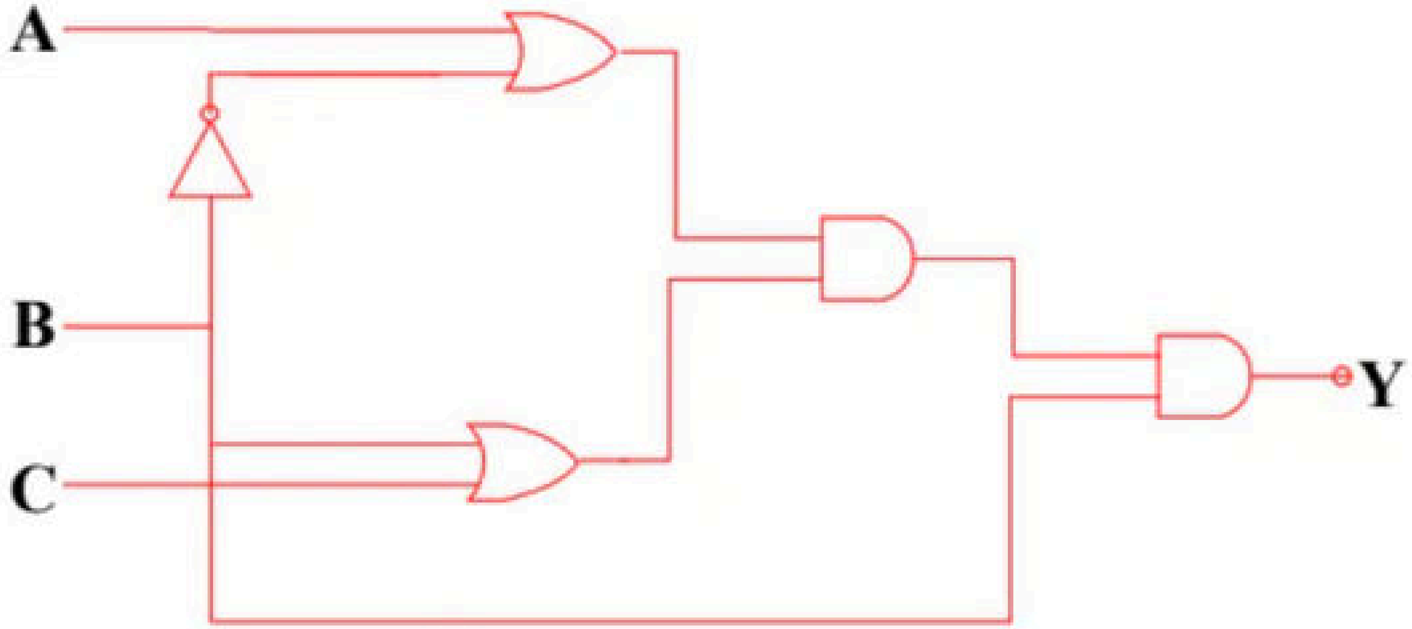
(c) $AB + C + DE$ (d) $AB + C(D + E)$



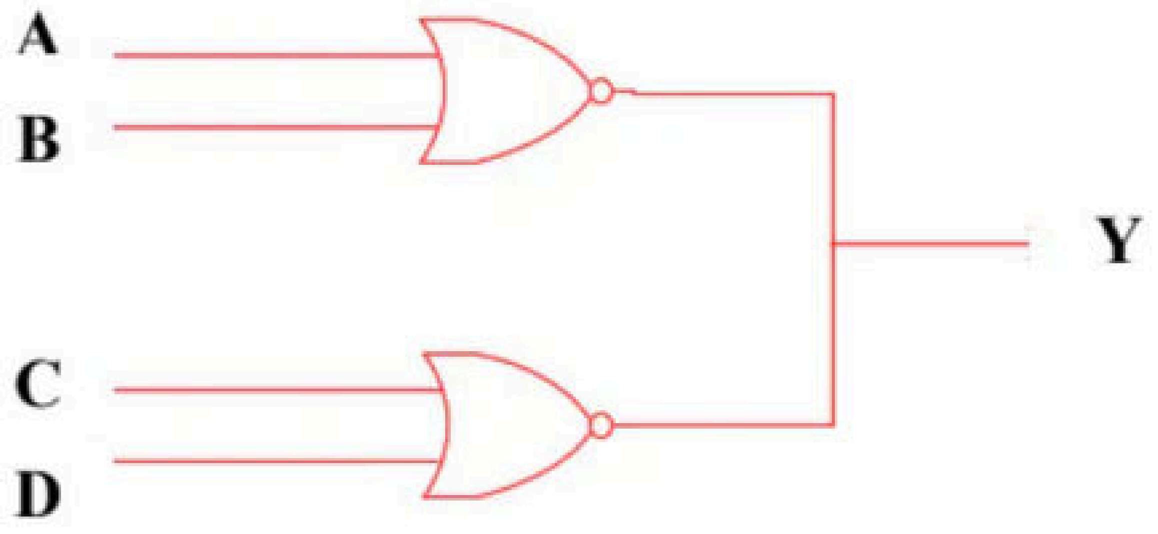
55. The output Y of the logic circuit shown in the figure is

(a) $A + BC$ (b) BC

(c) AB (d) $AB + C$



56. When two gates with open collector outputs are tied together as shown in the figure, the output obtained will be



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

(b) $\overline{A}\,\overline{B}\,\overline{C}\,\overline{D}$

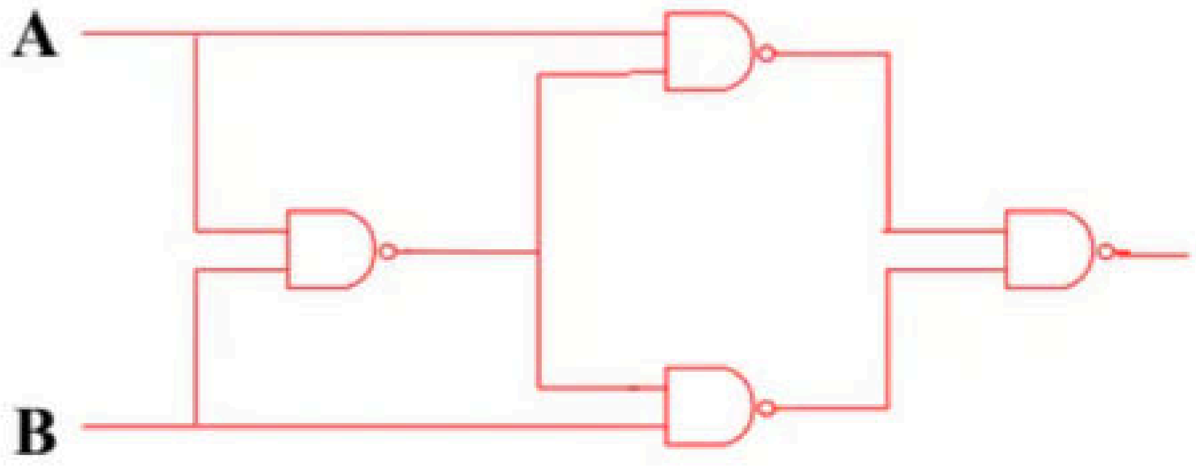
(c) $(\overline{A}+\overline{B})(\overline{C}+\overline{D})$

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

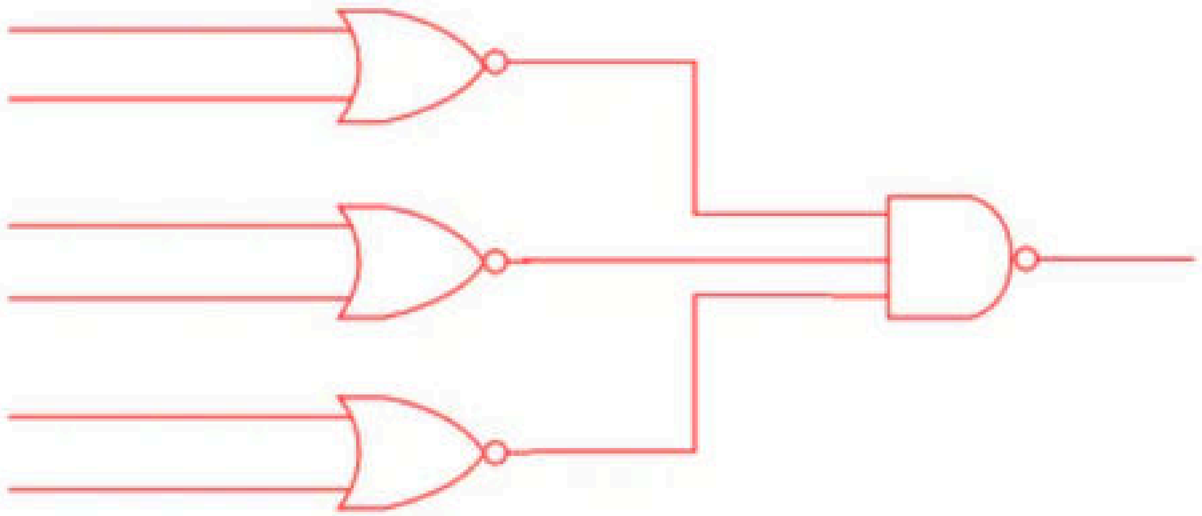
57. The circuit shown in the figure is functionally equivalent to

(a) NOR gate (b) OR gate

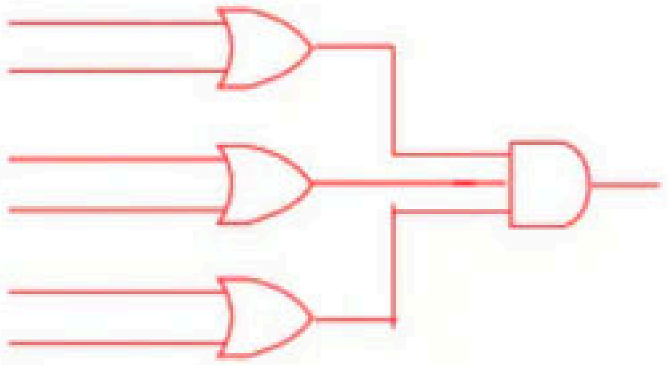
(c) EX-OR gate (d) NAND gate



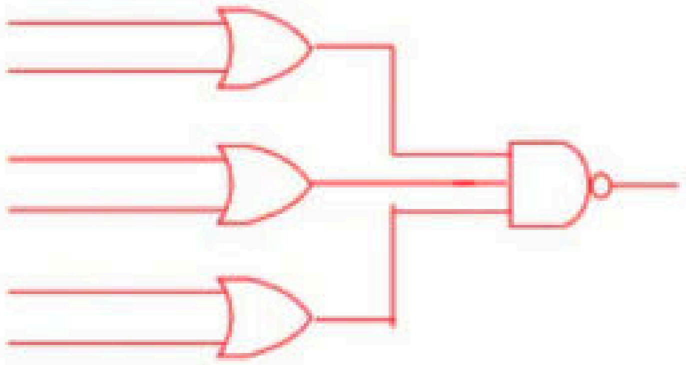
58. The circuit shown in fig is equivalent to



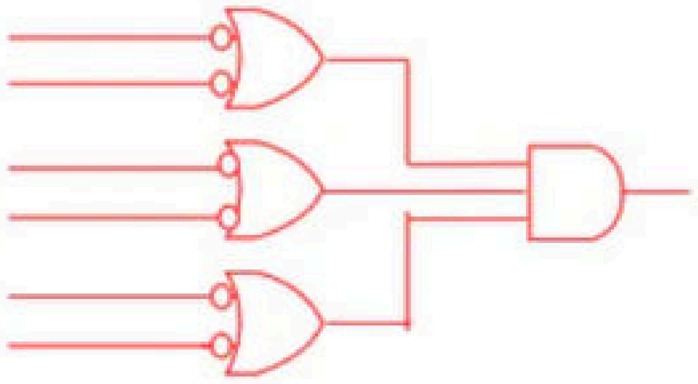
(a)



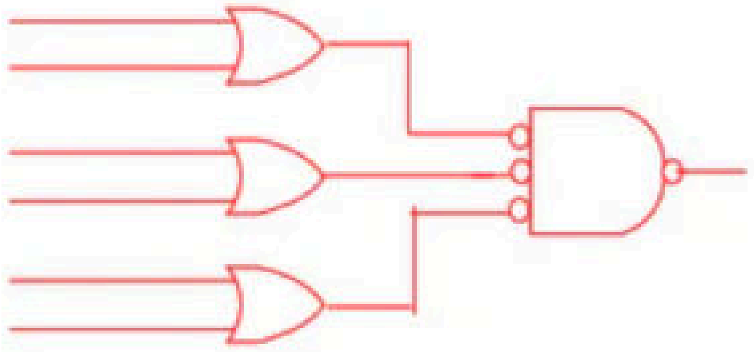
(b)



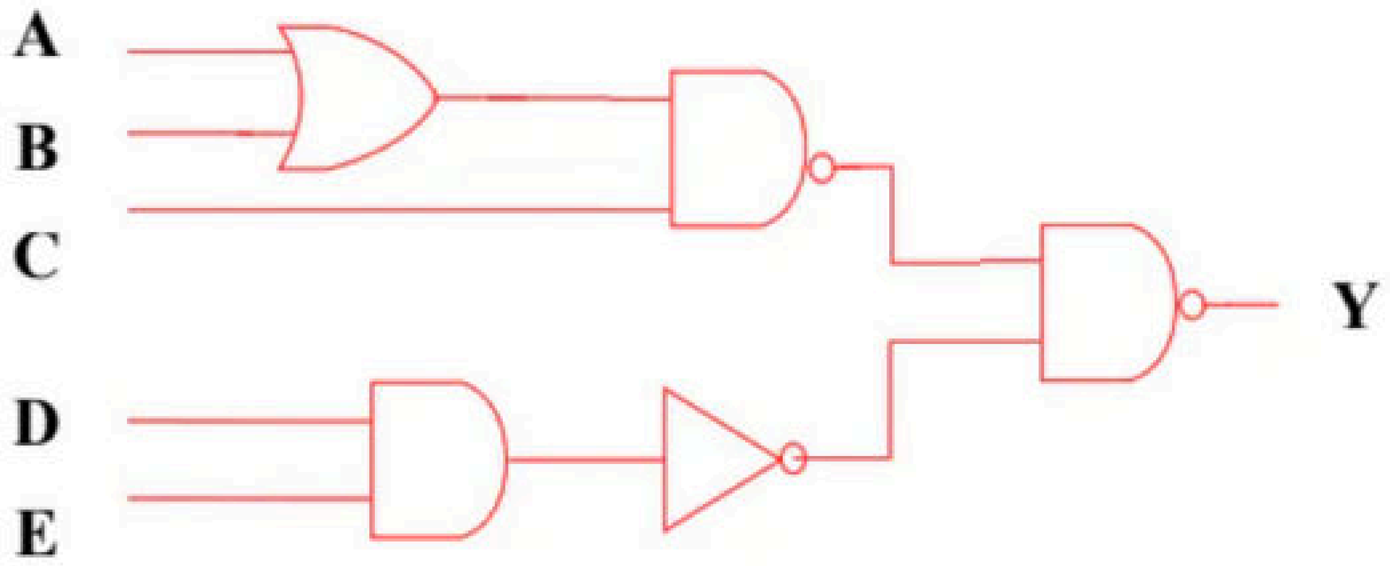
(c)



(d)



59. The output Y of the circuit shown in the figure is



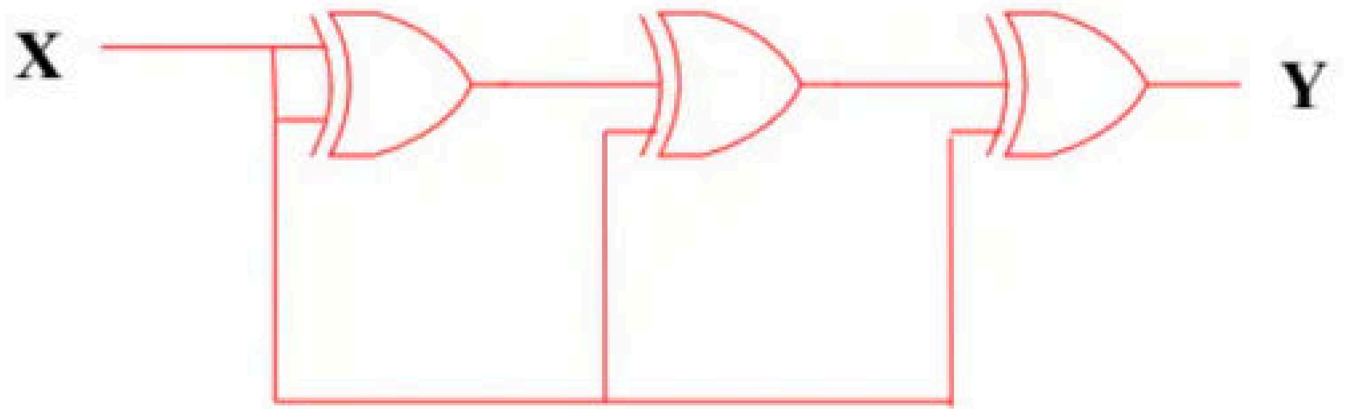
(a) $(A + B) C + DE$

(b) $AB + C (D + E)$

(c) $(A + B) C + D + E$

(d) $(AB + C) DE$

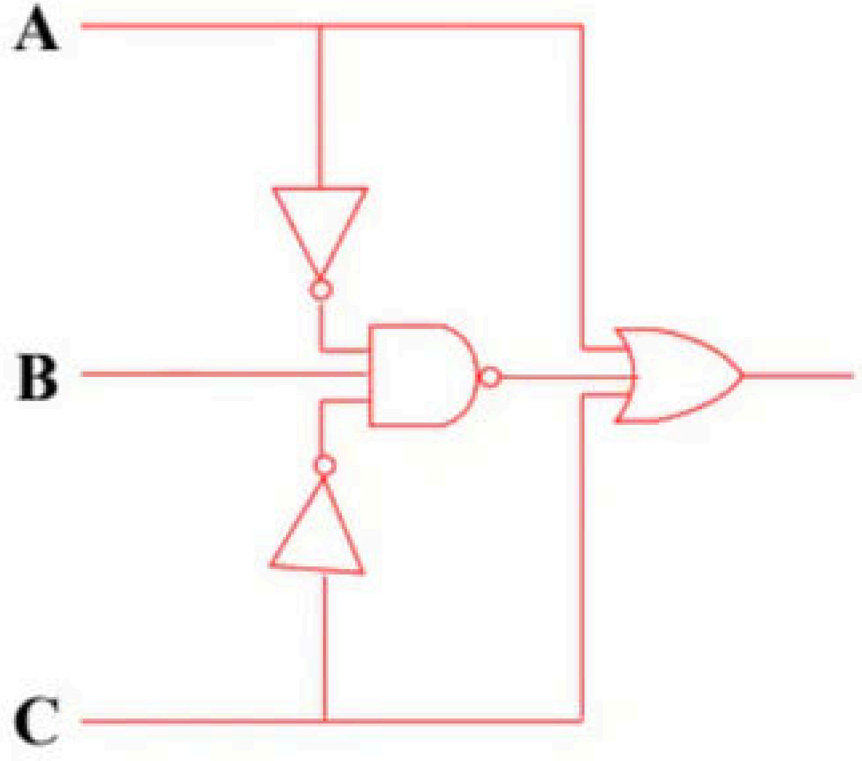
60. The output Y of the given circuit is.



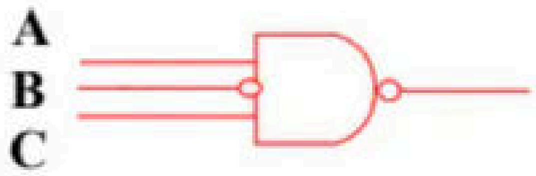
(a) 1 (b) ZERO

(c) X (d) $\overline{X}$

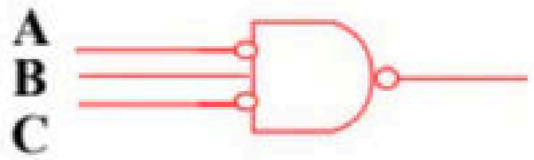
61. Which one of the following circuit is the Minimized logic circuit for the circuit shown in the figure?



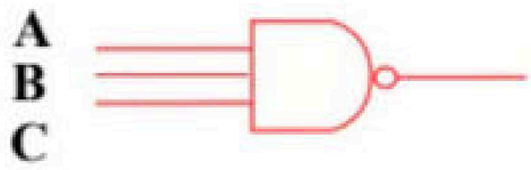
(a)



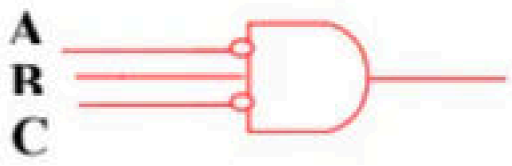
(b)



(c)



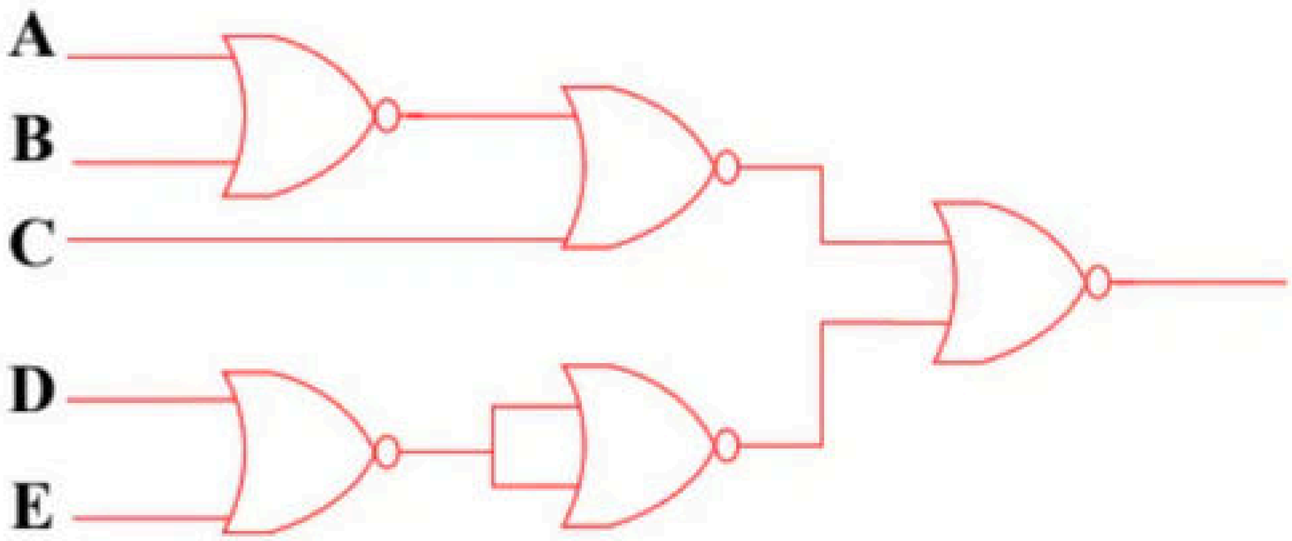
(d)



62. The circuit shown in the given figure realizes the function.

(a) $(\overline{A+B}+C)\,\overline{D}\,\overline{E}$ (b) $(\overline{A+B}+C)\,D\,\overline{E}$

(c) $(A+\overline{B+C})\,\overline{D}\,E$ (d) $(A+B+\overline{C})\,\overline{D}\,\overline{E}$



63. The logic operations of two combinational circuits in figure-I and figure-II are.

(a) Entirely different (b) identical

(c) Complementary (d) dual

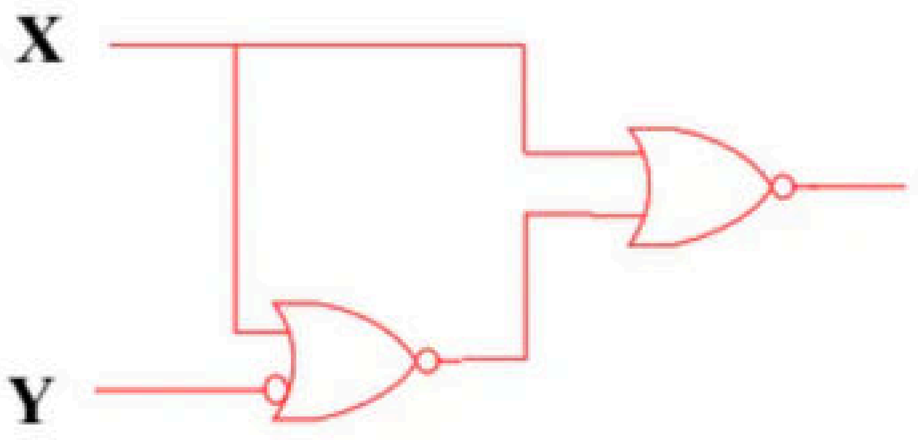


figure I

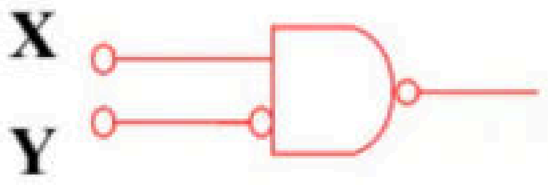


figure II

64. If the output of a logic gate is '1' when all its inputs are at logic '0'. The gate is either

(a) An NAND or NOR

(b) An AND or an EX-NOR

(c) AN OR or a NAND

(d) An EX-OR or an EX-NOR

65. How is inversion achieved using EX-OR gate?

(a) Giving input signal to the two input lines of the gate tied together

(b) Giving input to one input line and logic zero to the other line.

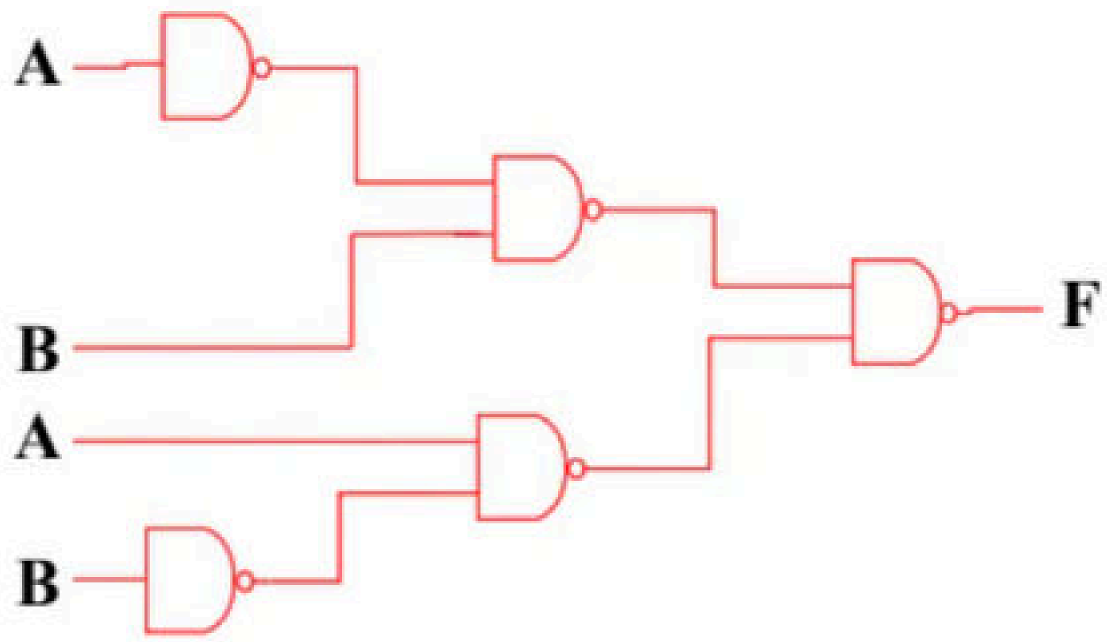
(c) Giving input to one input line and logic one to the other line.

(d) Inversion cannot be achieved using EX-OR gate.

66. The circuit shown below is functionally equivalent to

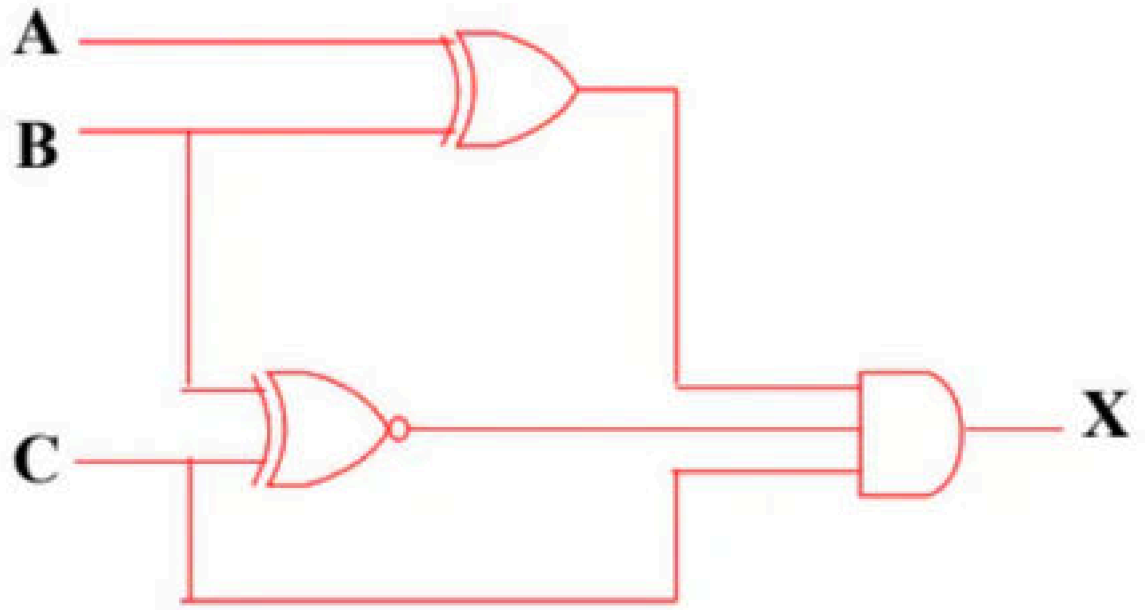
(a) NOR gate (b) OR gate

(c) EX-OR gate (d) NAND gate



67. Consider the following logic circuit:

What is the required input condition (A, B, C) to make the output X=1, for the below logic circuit?



(a) (1, 0, 1)

(b) (0, 0, 1)

(c) (1, 1, 1)

(d) (0, 1, 1)

68. The circuit shown below is to be used to implement the function $Z = f(A, B) = \overline{A} + B$

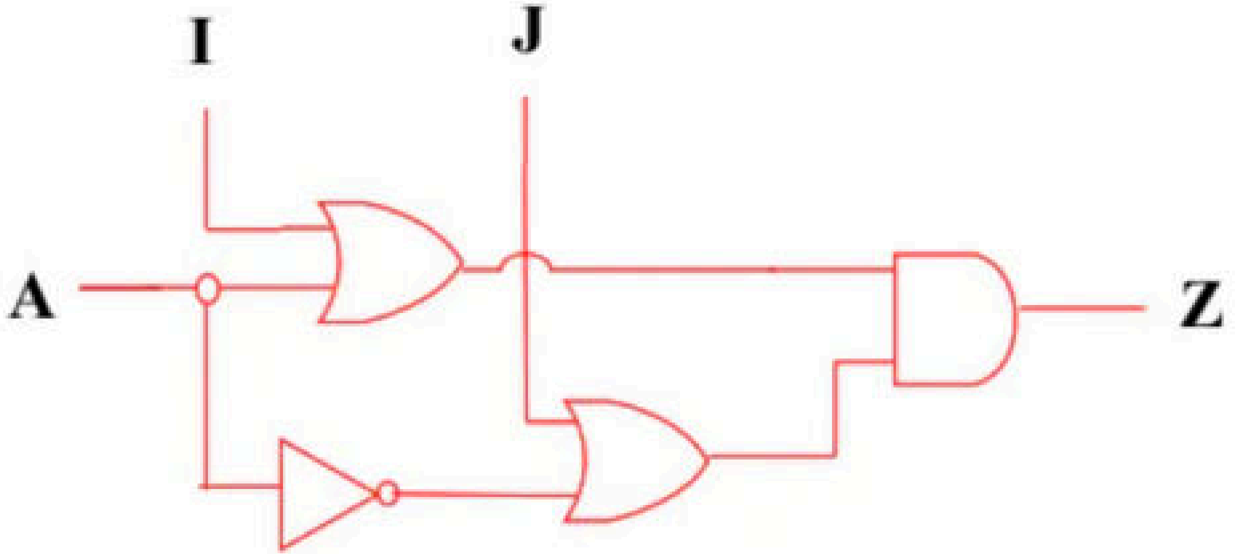
What values are to be selected for I and J?

(a) I=0, J=B

(b) I=A, J=B

(c) I=1, J=B

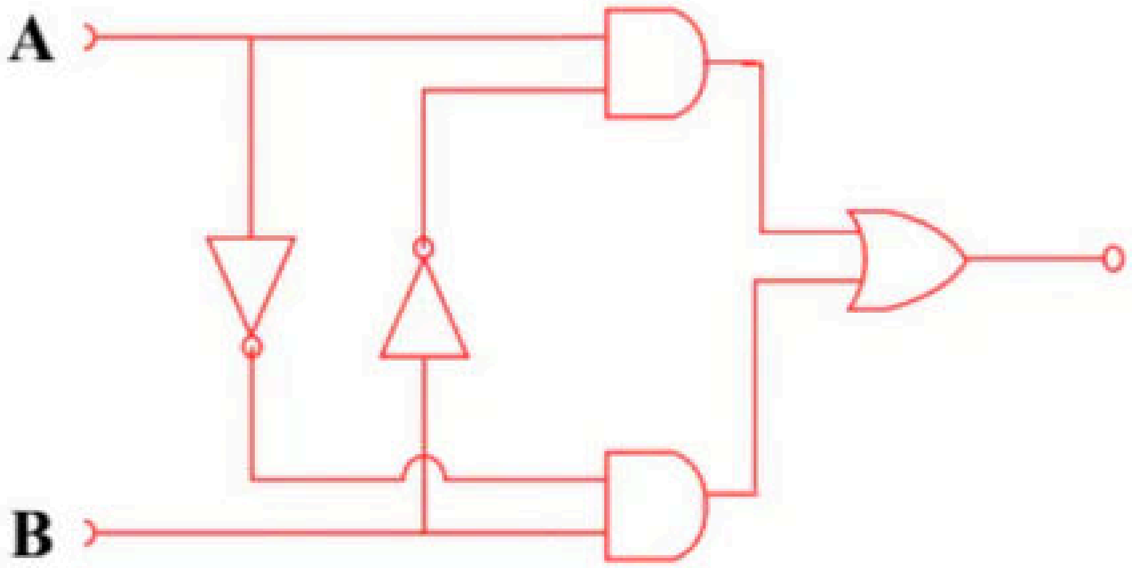
(d) I=$\overline{B}$, J=0



69. Which one of the following logical operations is performed by the digital circuit shown below?

(a) NOR (b) NAND

(c) EX-OR (d) OR



70. What is the Boolean expression $A \oplus B$ equivalent to?

(a) $A\,B + \overline{A}\,\overline{B}$

(b) $\overline{A}\,B + A\,\overline{B}$

(c) B

(d) $\overline{A}$

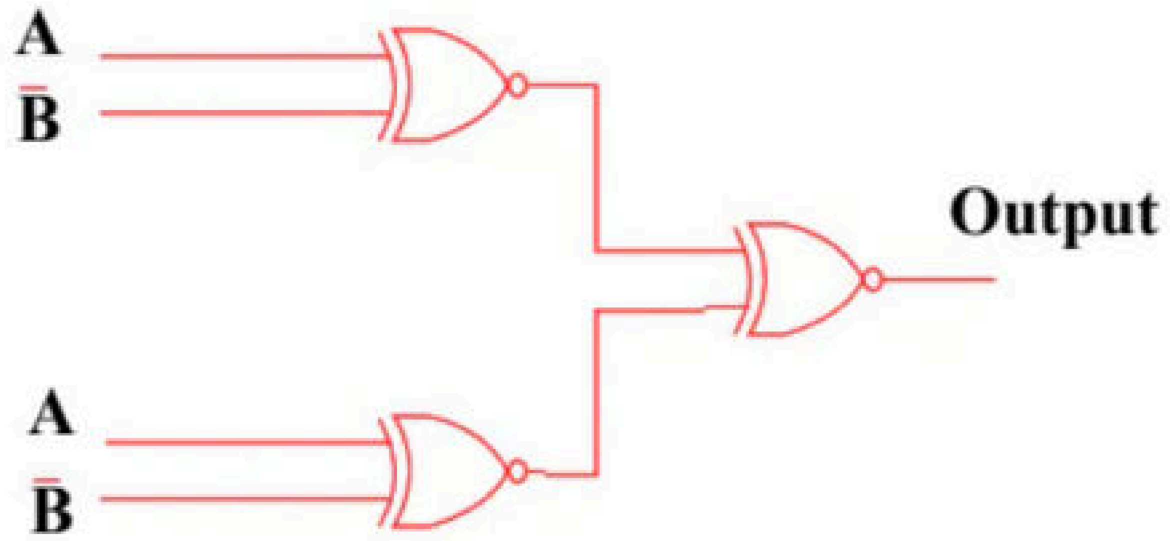
71. The output of the circuit shown in the figure is equal to

(a) 0

(b) 1

(c) $\overline{A}\,B + A\,\overline{B}$

(d) $(\overline{A * B}) * (\overline{A * B})$



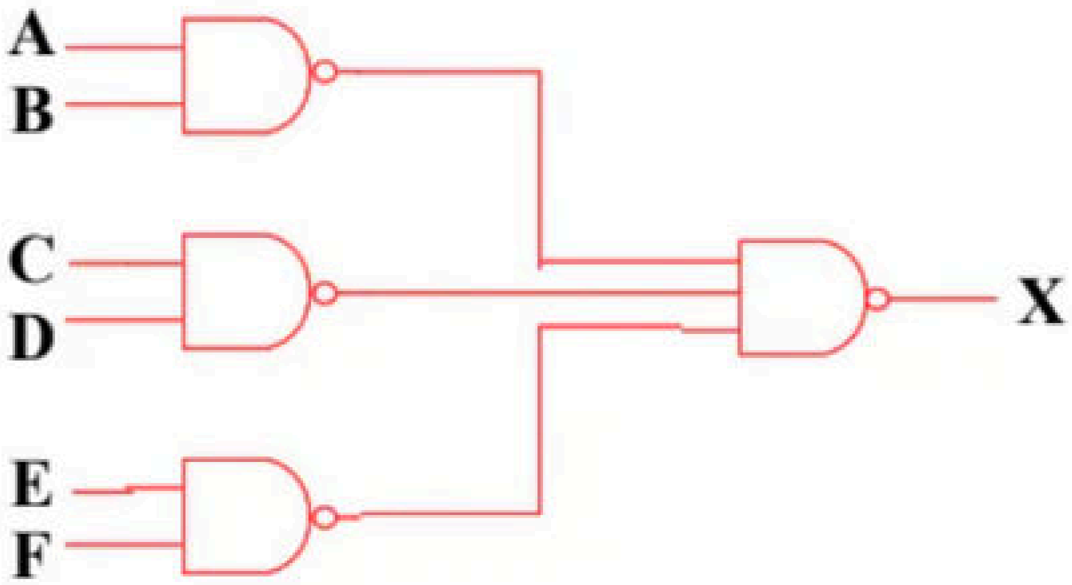
72. The output X of the above logic circuit is:

(a) $AB + CD + EF$

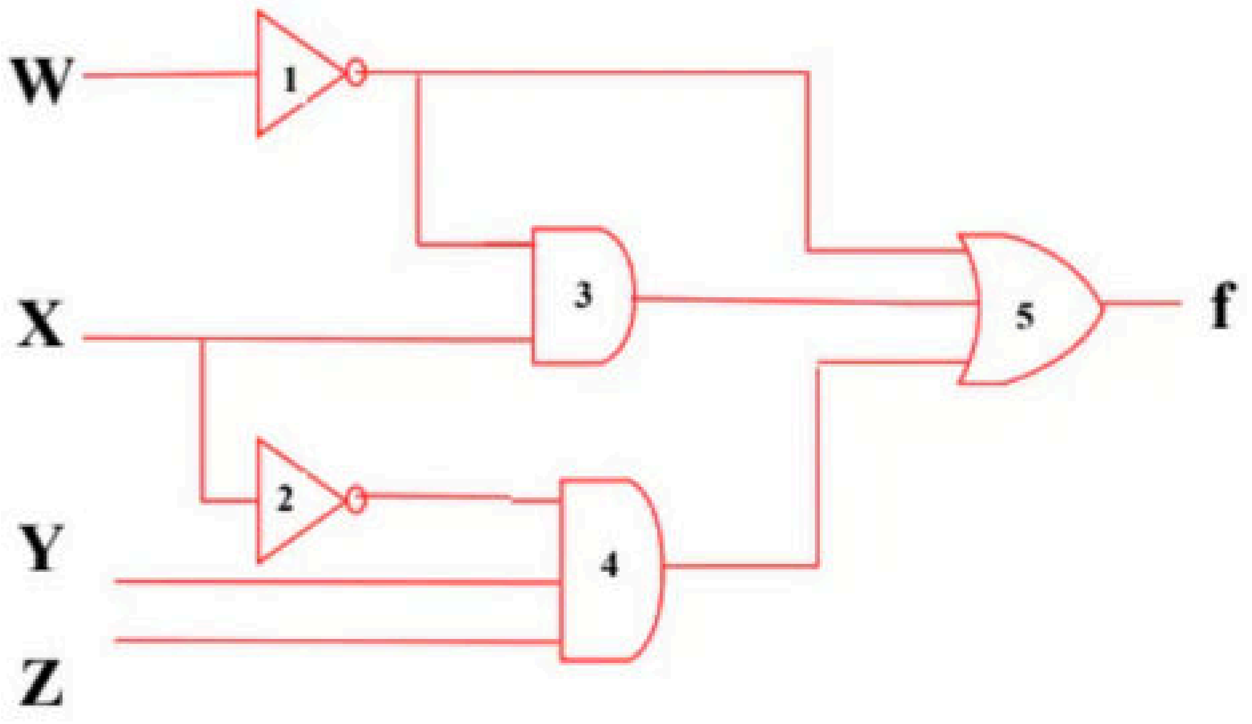
(b) $\overline{AB} + \overline{CD} + \overline{EF}$

(c) $(A + B)(C + D)(E + F)$

(d) $(\overline{A + B})(\overline{C + D})(\overline{E + F})$



73. Consider the following gate network:



Which one of the following gates is redundant?

(a) Gate No. 1 (b) Gate No. 2

(c) Gate No. 3 (d) Gate No. 4

74. The Boolean expression X (P, Q, R) = $\prod(0, 5)$ is to be realized using only two 2-input gates. Which are these gates?

(a) AND and OR

(b) NAND and OR

(c) AND and XOR

(d) OR and XOR

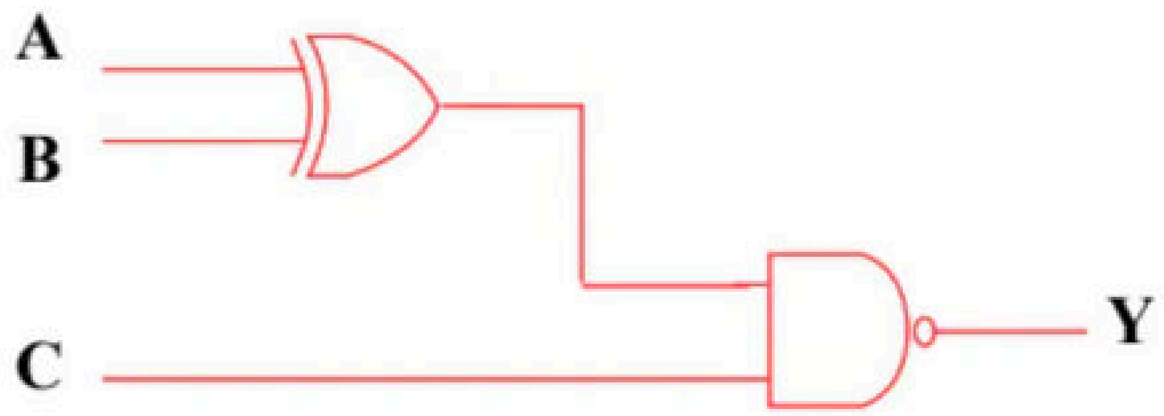
75. The Boolean expression for the output of the below logic circuit is: -

(a) $Y = \overline{A}\,\overline{B} + AB + \overline{C}$

(b) $Y = \overline{A}\,B + A\overline{B} + \overline{C}$

(c) $Y = A \oplus B + \overline{C}$

(d) $Y = AB + \overline{C}$



76. According to De-Morgan's 2nd theorem

(a) a NAND gate is always complimentary to an AND gate

(b) a NAND gate equivalent to a bubbled NAND gate

(c) a NAND gate equivalent to a bubbled AND gate

(d) a NAND gate equivalent to a bubbled OR gate

77. If $\bar{x}\,\bar{y} = 1$, then which one of the following is true?

(a) $\bar{x}y + \bar{y}x + xz = x\bar{y} + yz$

(b) $\bar{x}\,\bar{y}\,\bar{z} + xyz = xy\bar{z} + \bar{x}\,\bar{y}\,\bar{z}$

(c) $\bar{x}y + \bar{y}x = xy + \bar{x}\,\bar{y}$

(d) $\bar{x}yx = 1$

78. There are four Boolean variables x_1, $x_{2,}$ $x_{3,}$ x_4 following functions are defined on sets of them:

$f(x_3, x_2, x_1) = \sum(3,4,5)$,

$g(x_4, x_3, x_2) = \sum(1,6,7)$, $h(x_4,x_3,x_2,x_1,) = fg$ .then $h(x_4,x_3,x_2,x_1,)$ is :

(a) zero

(b) $\sum(3,12,13)$

(c) $\sum(3,4,5,1,6,7)$

(d) $\sum(3,12,15)$,

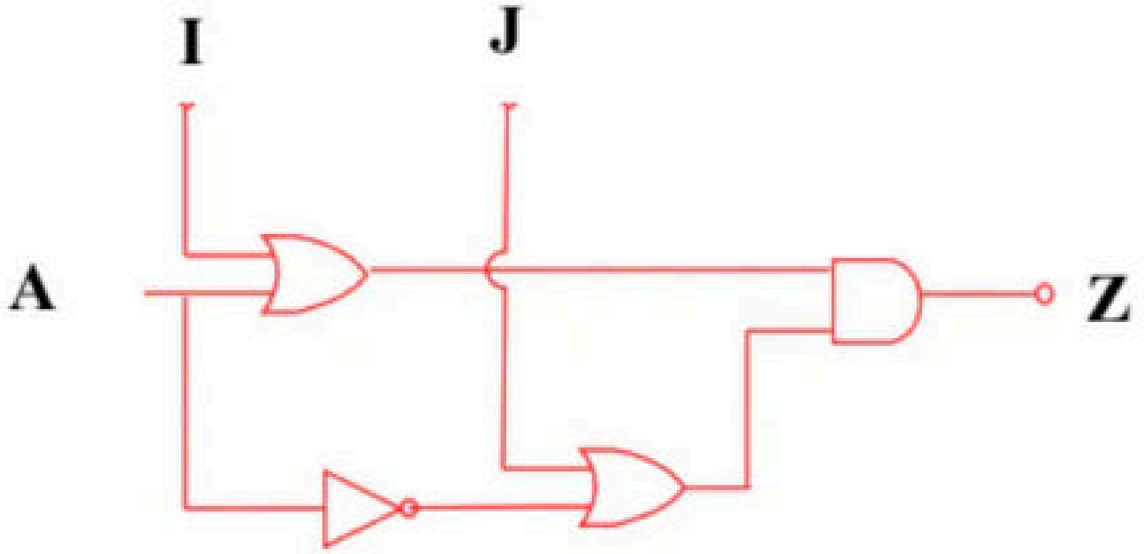
79. The circuit given in the figure is to be used to implement the function $Z = f(A, B) = \overline{A} + B$. What values should be selected for I and J?

(a) I = 0; J = B

(b) I = 1; J = B

(c) I = 1; J = B

(d) I = B; J = 0



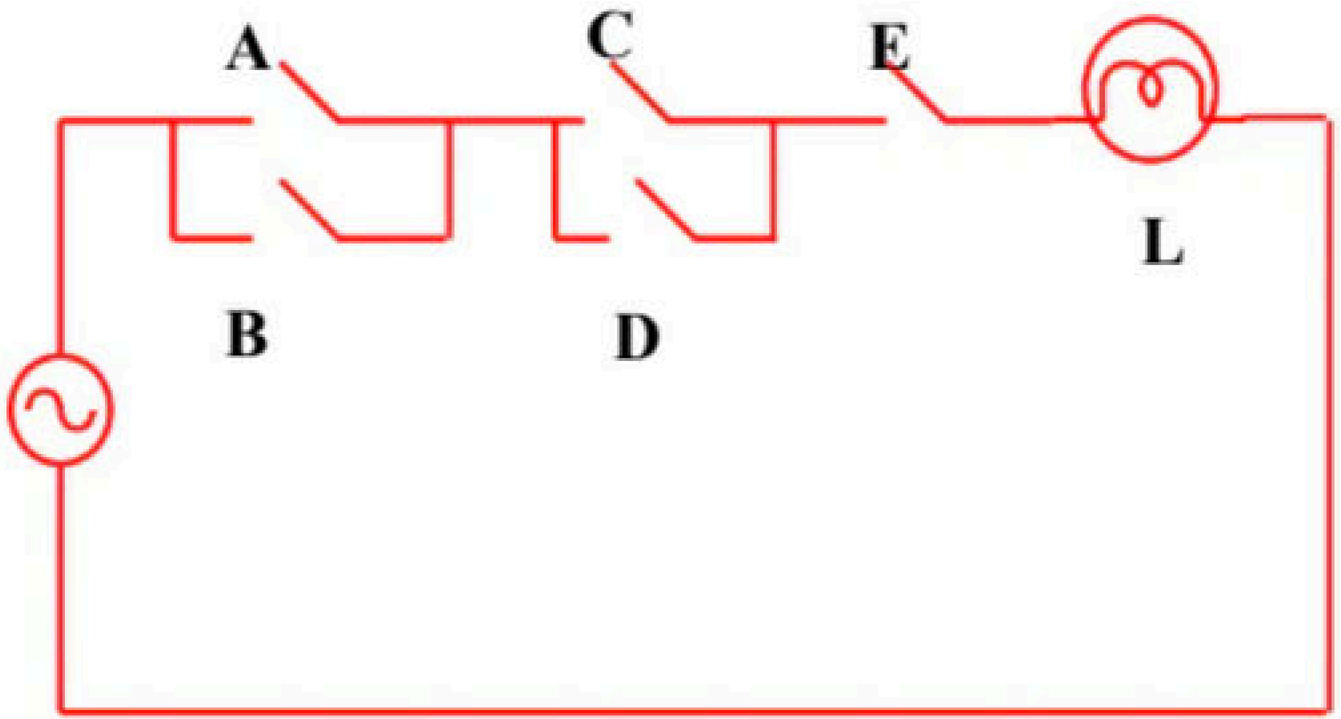
80. The switching circuit given in the figure can be expressed in binary logic notation as

(a) $L = (A + B)(C + D)E$

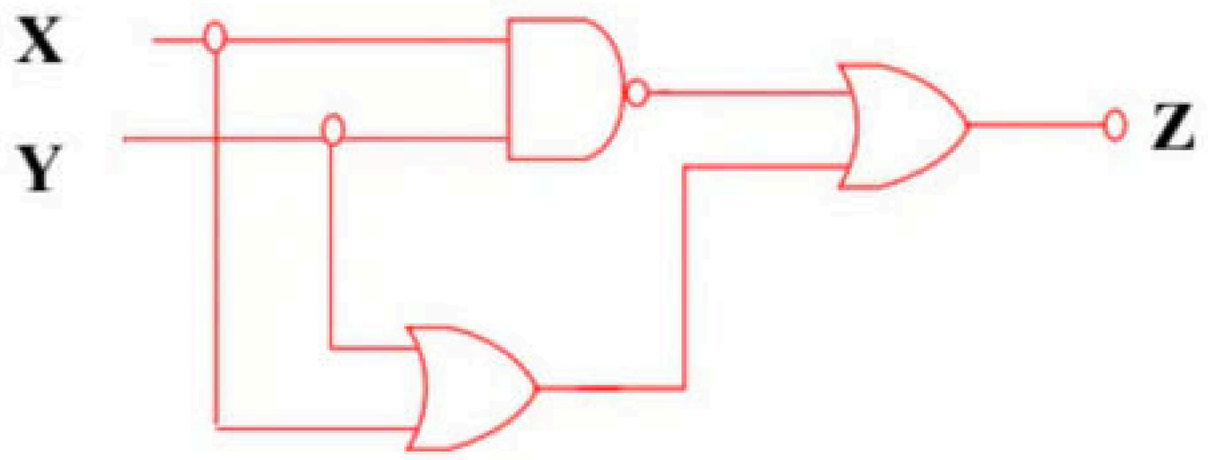
(b) $L = AB + CD + E$

(c) $L = E + (A+B)(C+D)$

(d) $L = (AB + CD)E$



81. Which of the following is the truth table of the given logic circuit.



(a)

X	Y	Z
0	0	1
0	1	1
1	0	1
1	1	1

(b)

X	Y	Z
0	0	0
0	1	1
1	0	1
1	1	1

(c)

X	Y	Z
0	0	1
0	1	0
1	0	0
1	1	0

(d)

X	Y	Z
0	0	0
0	1	1
1	0	1
1	1	0

82. The output of an EX-OR gate with A and B as inputs will be.

(a) $AB + \overline{AB}$

(b) $(A + B)\ \overline{(A + B)}$

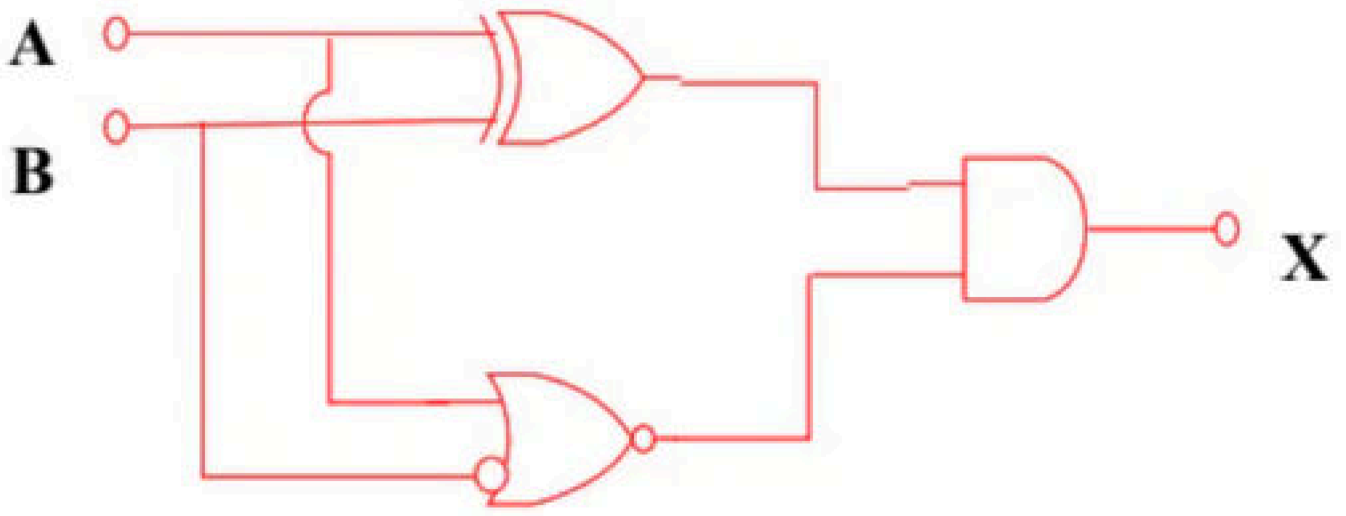
(c) $(A + B)\ \overline{AB}$

(d) $\overline{A + B} + AB$

83. The output X of the circuit shown in the figure will be.

(a) AB (b) $\overline{A}B$

(c) $A\overline{B}$ (d) $\overline{A}\,\overline{B}$



84. Consider the following statements.

(a) A NAND gate is equivalent to an OR gate with its inputs inverted

(b) A NOR gate is equivalent to an AND gate with its inputs inverted

(c) A NAND gate is equivalent to an OR gate with its output inverted

(d) A NOR gate is equivalent to an AND gate with its output inverted

Which of these statements are correct?

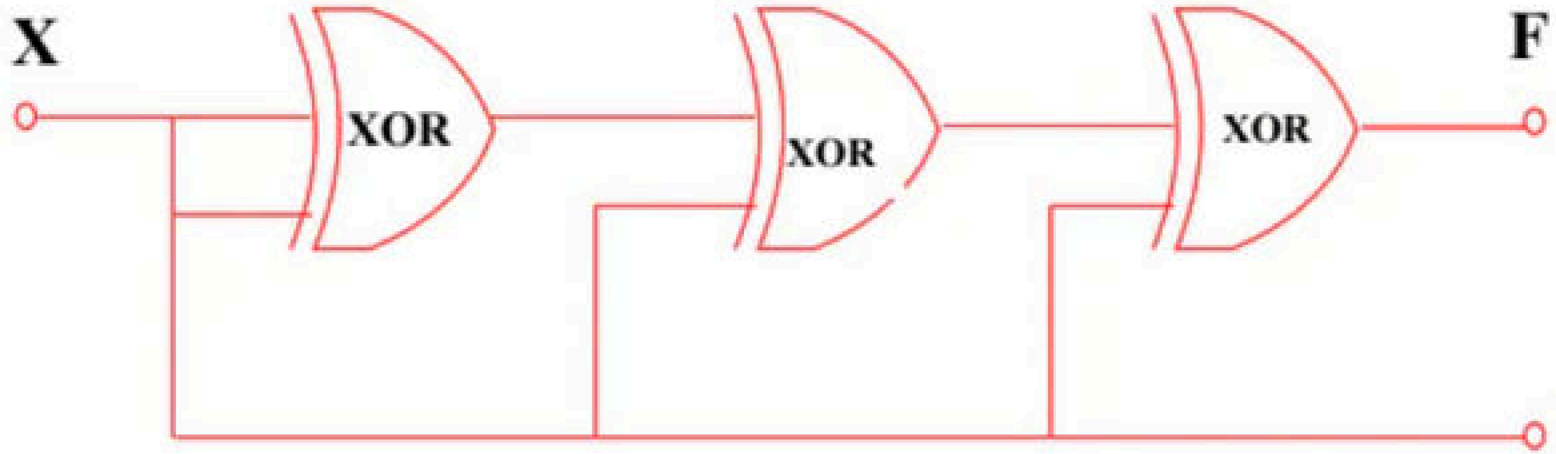
(a) 1 and 2 (b) 2 and 3

(c) 3 and 4 (d) 1 and 4

85. For the circuit shown in the given figure the output F will be.

(a) 1 (b) 0

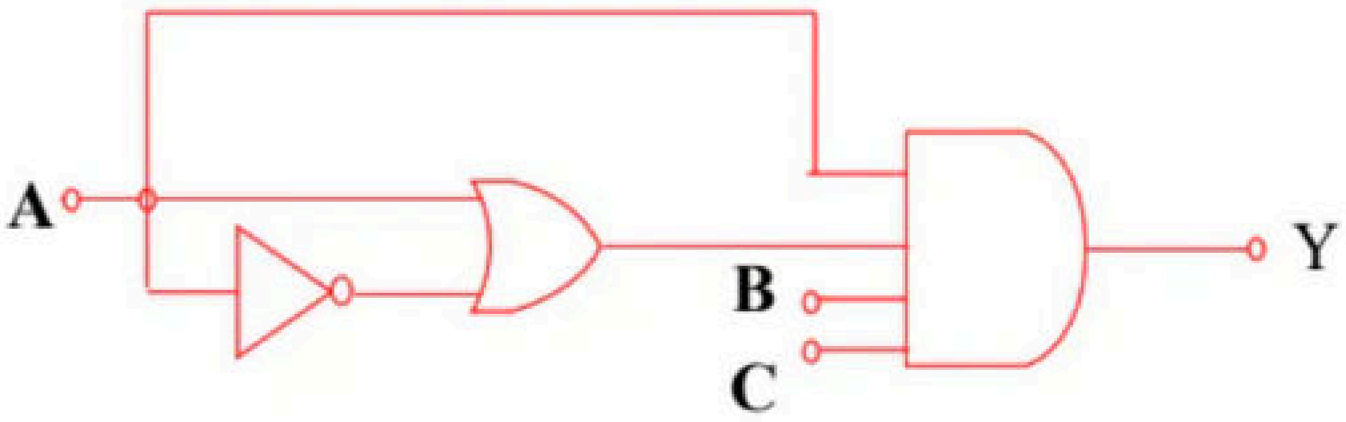
(c) X (d) $\overline{X}$



86. The Boolean expression for the output Y in the logic circuit is.

(a) $A\overline{B}C$ (b) ABC

(c) $\overline{A}BC$ (d) $\overline{A}\,\overline{B}\,\overline{C}$



87. Consider the following:

Any combinational circuit can be built using.

1. NAND gate
2. NOR gate
3. EX-OR gate
4. Multiplexers

Which of these are correct?

(a) 1, 2 and 3

(b) 1, 3 and 4

(c) 2, 3 and 4

(d) 1, 2 and 4

88. The AND function can be realized by using only n number of NOR gates. What is n =?

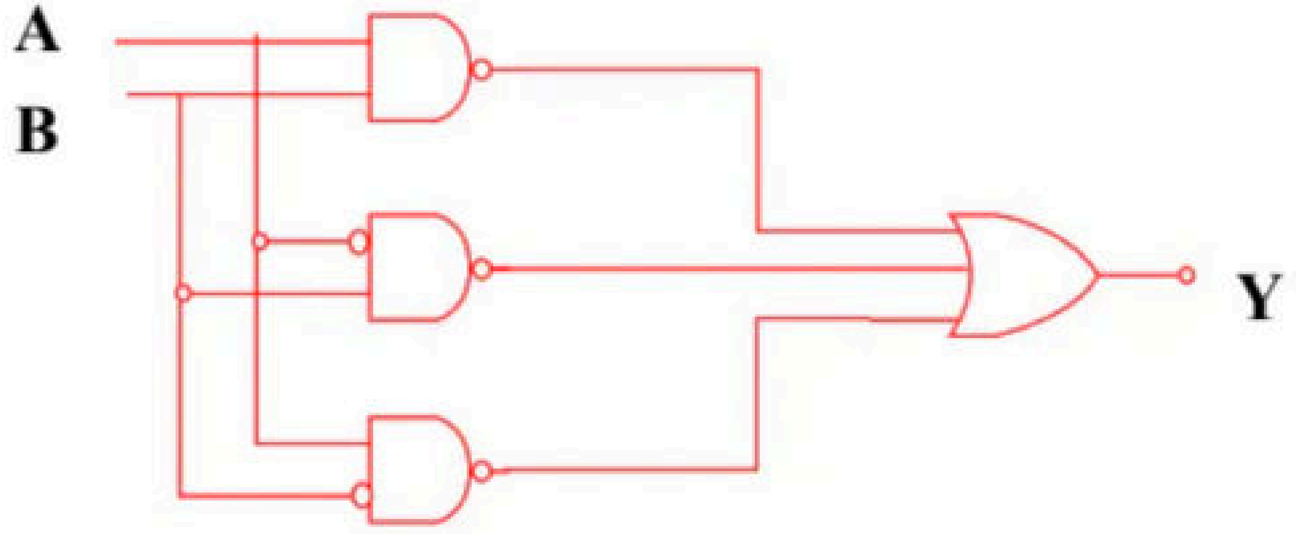
(a) 2 (b) 3

(c) 4 (d) 5

89. In the given circuit, the output Y equals which one of the following?

(a) A+B (b) $\overline{A}B + A\overline{B}$

(c) AB (d) 1



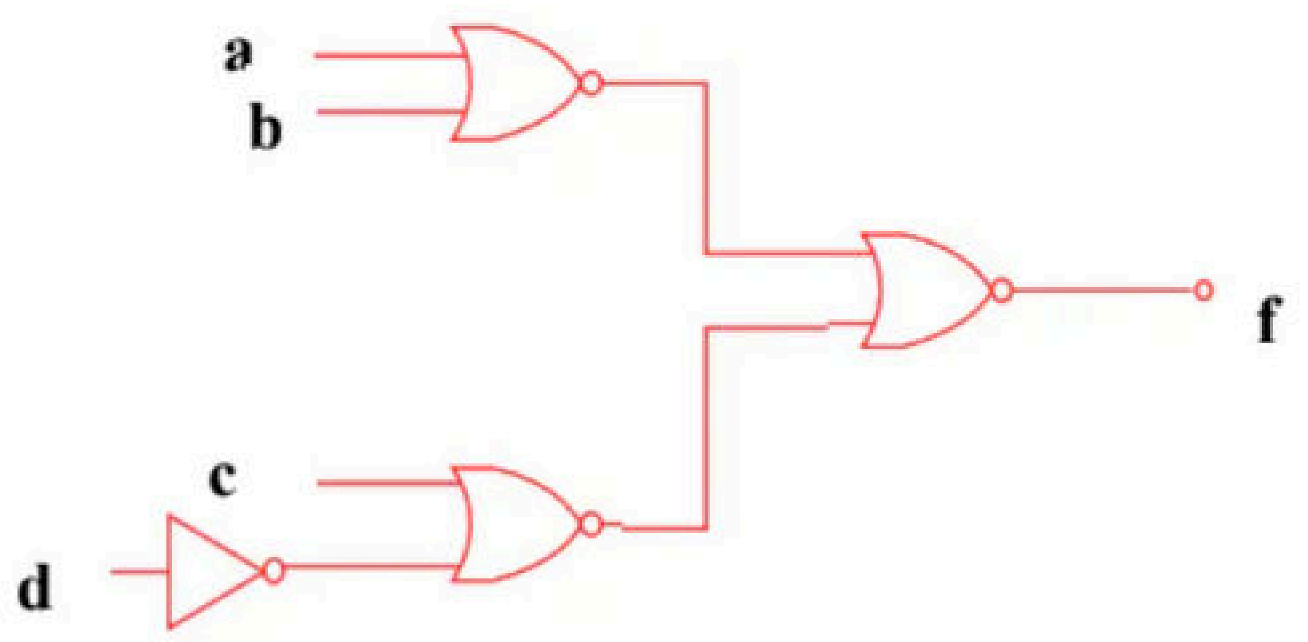
90. Which one of the following is the correct output (f) of the below circuit?

(a) $(a + b)(c + \overline{d})$

(b) $(\overline{a} + \overline{b})(c + \overline{d})$

(c) $(a + \overline{b})(c + \overline{d})$

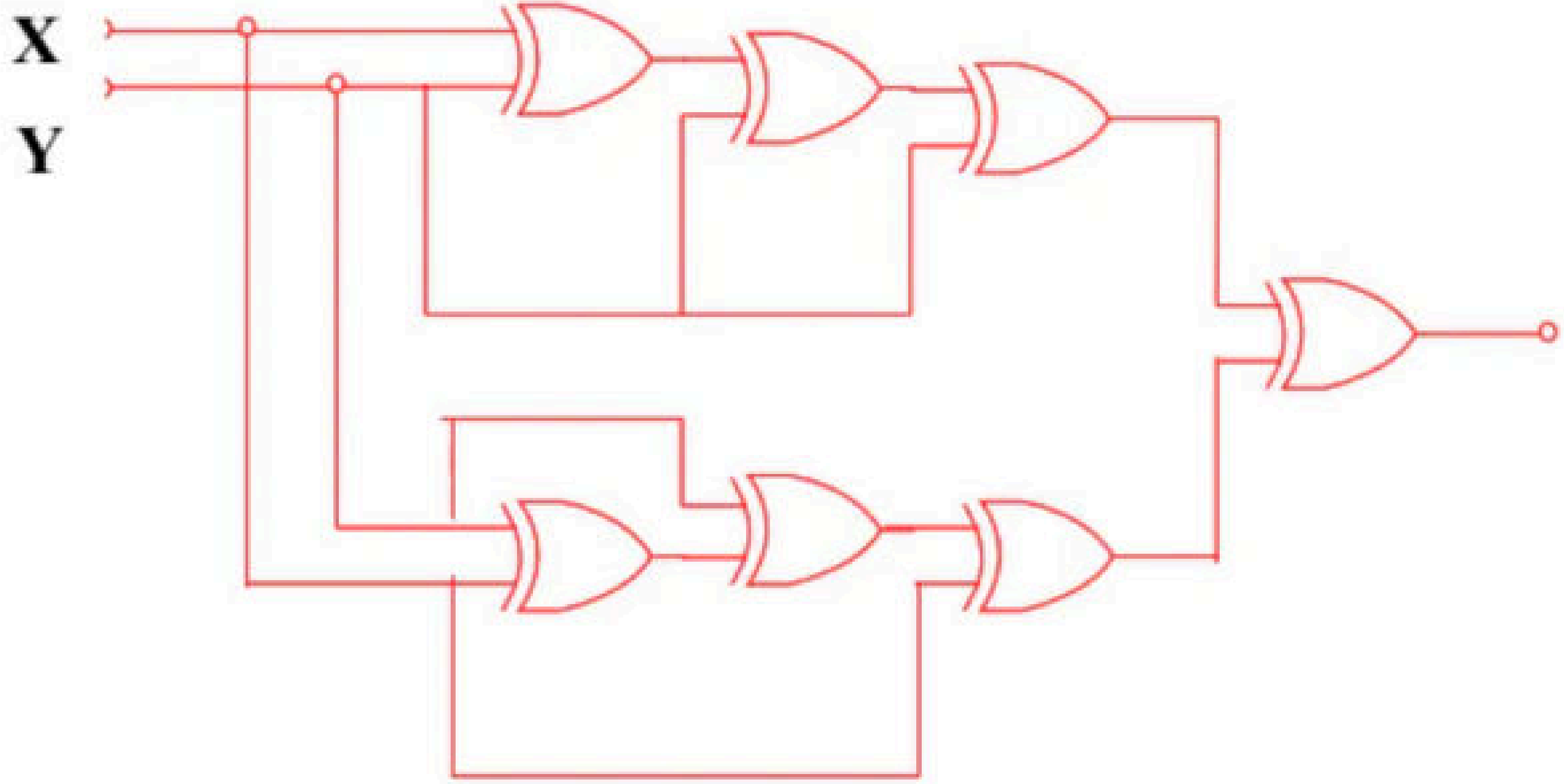
(d) $(a + b)(\overline{c} + \overline{d})$



91. The circuit shown in the figure below generates the function of

(a) $X \oplus Y$ (b) 0

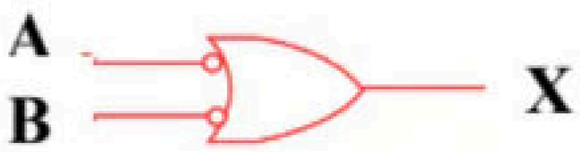
(c) $X\overline{Y} + YX + \overline{Y}X$ (d) $X.\overline{Y}$



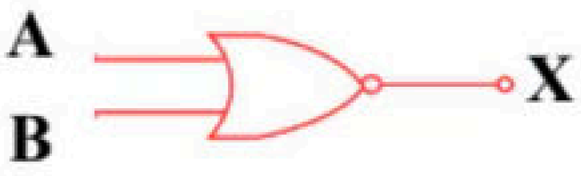
92. Match List-I with List-II and select the correct answer using the codes given below the L

List I

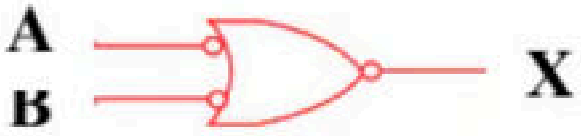
(a)



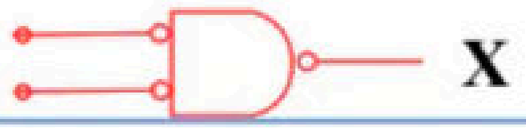
(b)



(c)



(d)



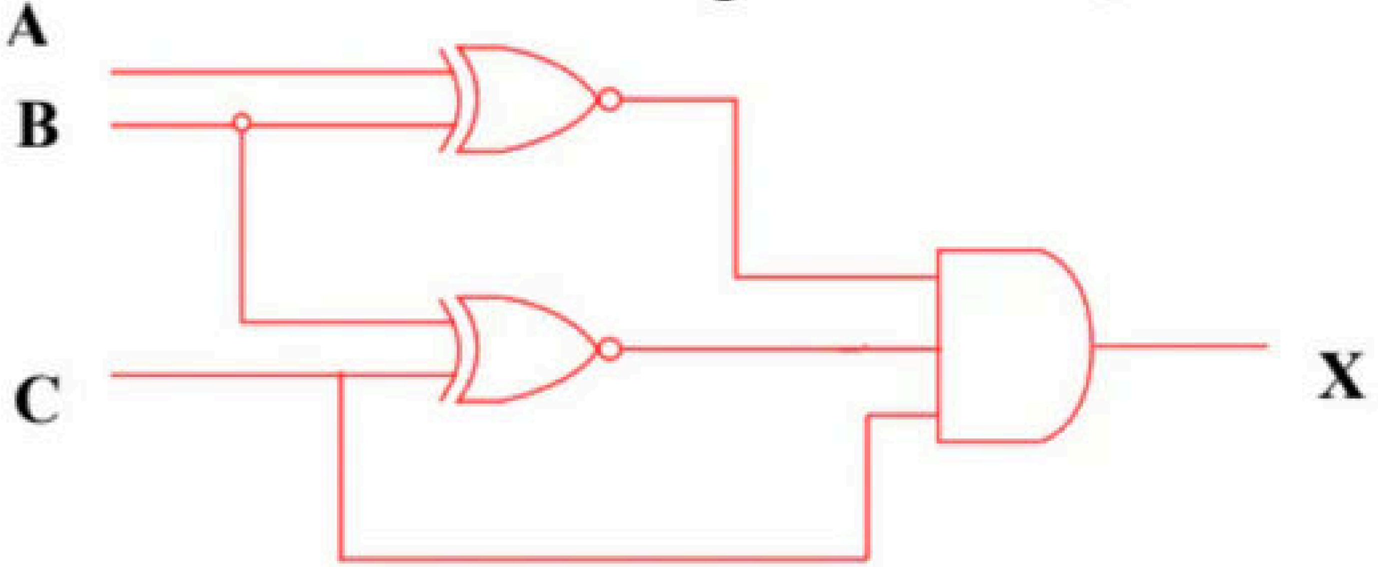
List-II

1. AB
2. $\overline{AB}$
3. $A+B$
4. $\overline{A+B}$

Codes

	A	**B**	**C**	**D**
(a)	3	1	4	2
(b)	2	1	4	3
(c)	3	4	1	3
(d)	2	4	1	3

93. For logic circuits shown, the required inputs A, B and C to make the output X=1 are, respectively



(a) 1, 0 and 1 (b) 0, 0 and 1

(c) 1, 1 and 1 (d) 0, 1 and 1

94. If the output of a logic Gate is '1' When all its inputs are at logic '0', the gate is either

(a) A NAND and a NOR (b) An AND and an EX-NOR

(c) An OR and a NAND (d) An EX-OR and an EX-NOR

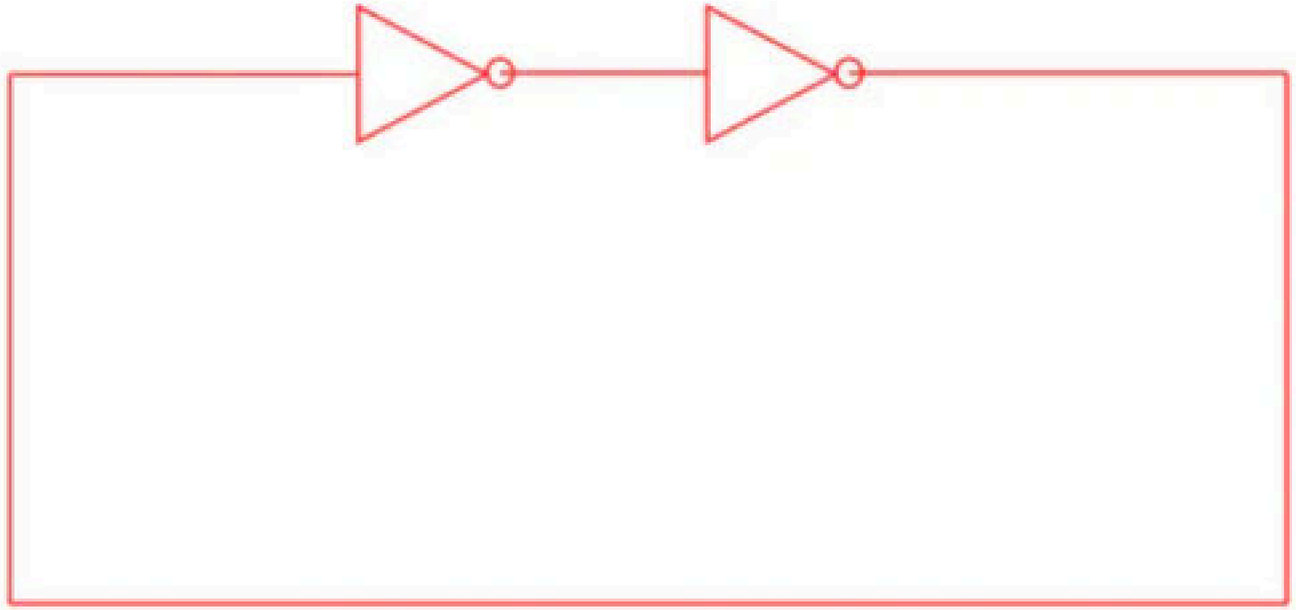
95. The digital circuit using two invertors as shown in the below figure acts as?

(a) a Bi-stable Multivibrator

(b) an Astable Multivibrator

(c) a Monostable Multivibrator

(d) an oscillator spectrum



96. (a) Let * be a Boolean operation defined as

$A*B = AB + \overline{A}\,\overline{B}$

If $C = A * B$ then evaluate and fill in the blanks:

i. $A * A =$ ________

ii. $C * A =$ ________

(b) Solve the following Boolean equations for the values of A, B and C:

$AB + \overline{A}C = 1$

$AC + B = 0$

97. What values of A, B, C and D satisfy the following simultaneous Boolean equations?

$$\overline{A} + AB = 0,\ AB = AC,\ AB + A\overline{C} + CD = \overline{CD}$$

(A) A=1, B=0, C=0, D=1

(B) A=1, B=1, C=0, D=0

(C) A =1, B=0, C=1, D=1

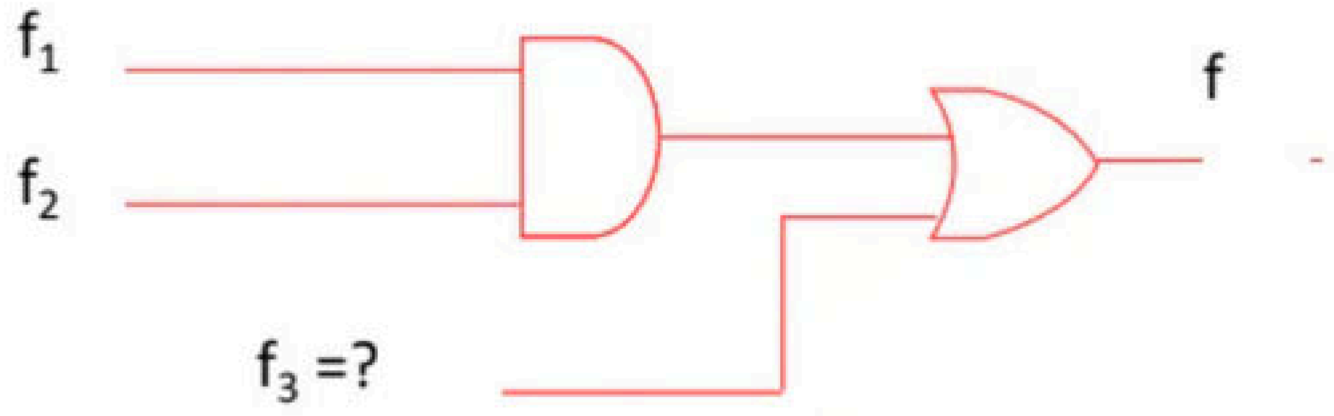
(D) A=0, B=0, C=0, D=0

98. Consider the logic circuit shown in the figure below. The function f_1, f_2 and f (In canonical sum of products form in decimal notation) are

$f_1(w, x, y, z) = \sum 8,9,10$

$f_2(w, x, y, z) = \sum 7,8,12,13,14,15$

$f(w, x, y, z) = \sum 8,9$



The function f_3 is

(A) $\sum 9,10$ (B) $\sum 9$

(C) $\sum 1,8,9$ (D) $\sum 8,10,15$

99. What happens when a bit-string is XOR' ed with itself n-times as shown:

[B $\oplus$ (B $\oplus$ (B $\oplus$ (B ... ... n times]

(A) complements when n is even

(B) complements when n is odd

(C) divides by 2^n always

(D) remains unchanged when n is odd

100. The simultaneous equations on the Boolean variables x, y, z and w, have the following solution for x, y, z and w, respectively:

$$x + y + z = 1$$
$$xy = 0$$
$$xz + w = 1$$
$$xy + \overline{z}\overline{w} = 0$$

(A) 0 1 0 0 (B) 1 1 0 1

(C) 1 0 1 1 (D) 1 0 0 0

101. Define the connective * for the Boolean variables X and Y as: $X * Y = XY + \bar{X}\bar{Y}$. Let $Z = X*Y$. Consider the following expressions P, Q and R.

P : $X = Y*Z$

Q : $Y = X*Z$

R : $X*Y*Z = 1$

Which of the following is TRUE?

(A) Only P and Q are valid.

(B) Only Q and R are valid.

(C) Only P and R are valid.

(D) All P, Q, R are valid.

102. Let # be a binary operator defined as $X\#Y = X' + Y'$ where X and Y are Boolean variables.

Consider the following two statements.

(S1) $(P\#Q)\#R = P\#(Q\#R)$

(S2) $Q\#R = R\#Q$

Which of the following is/are true for the Boolean variables P, Q and R?

(A) Only S1 is true

(B) Only S2 is true

(C) Both S1 and S2 are true

(D) Neither S1 nor S2 are true

103. Let, $x_1 \oplus x_2 \oplus x_3 \oplus x_4 = 0$ where x_1, x_2, x_3, x_4 are Boolean variables, and $\oplus$ is the XOR operator Which one of the following must always be TRUE?

(A) $x_1 x_2 x_3 x_4 = 0$

(B) $x_1 x_3 + x_2 = 0$

(C) $\bar{x}_1 \oplus \bar{x}_3 = \bar{x}_2 \oplus \bar{x}_4$

(D) $x_1 + x_2 + x_3 + x_4 = 0$

104. Let $\oplus$ and $\odot$ denote the Exclusive OR and Exclusive NOR operations, respectively. Which of the following is NOT CORRECT?

(A) $\overline{P \oplus Q} = P \odot Q$ (B) $\overline{P} \oplus Q = P \odot Q$

(C) $\overline{P} \oplus \overline{Q} = P \odot Q$ (D) $(P \oplus \overline{P}) \oplus Q = (P \odot \overline{P}) \odot Q$

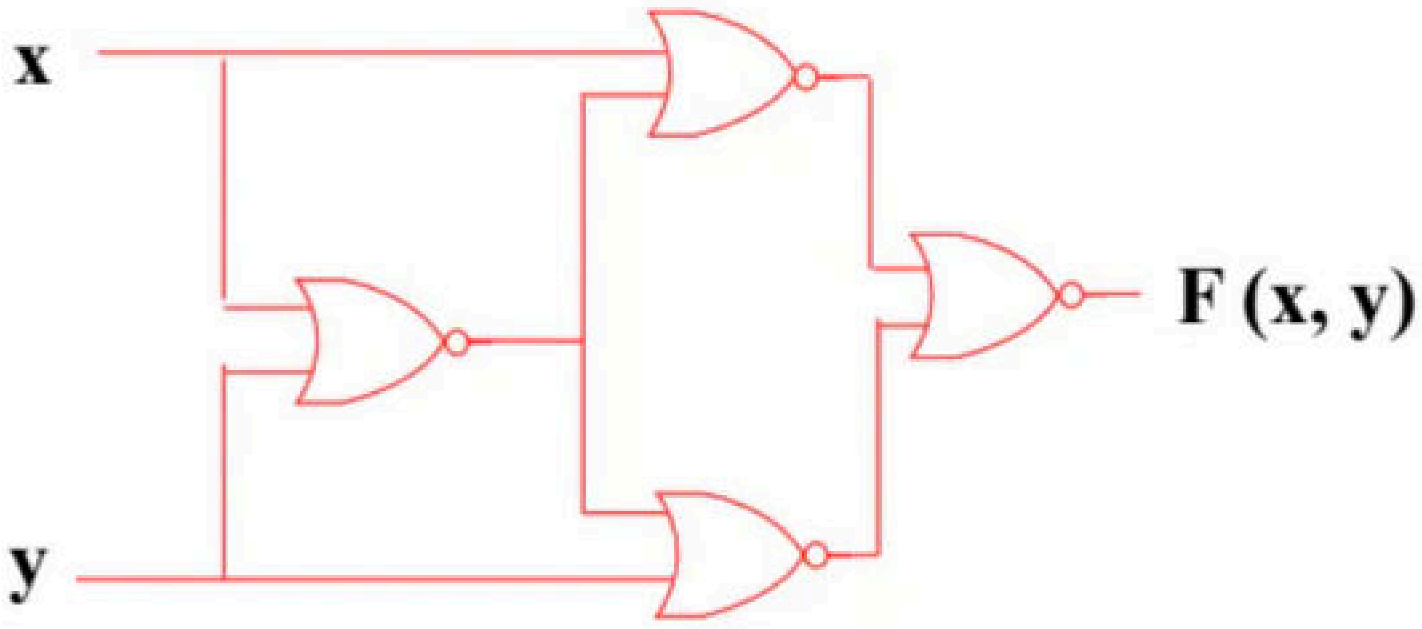
105. Identify the logic function performed by the circuit shown

(a) exclusive OR

(b) exclusive NOR

(c) NAND

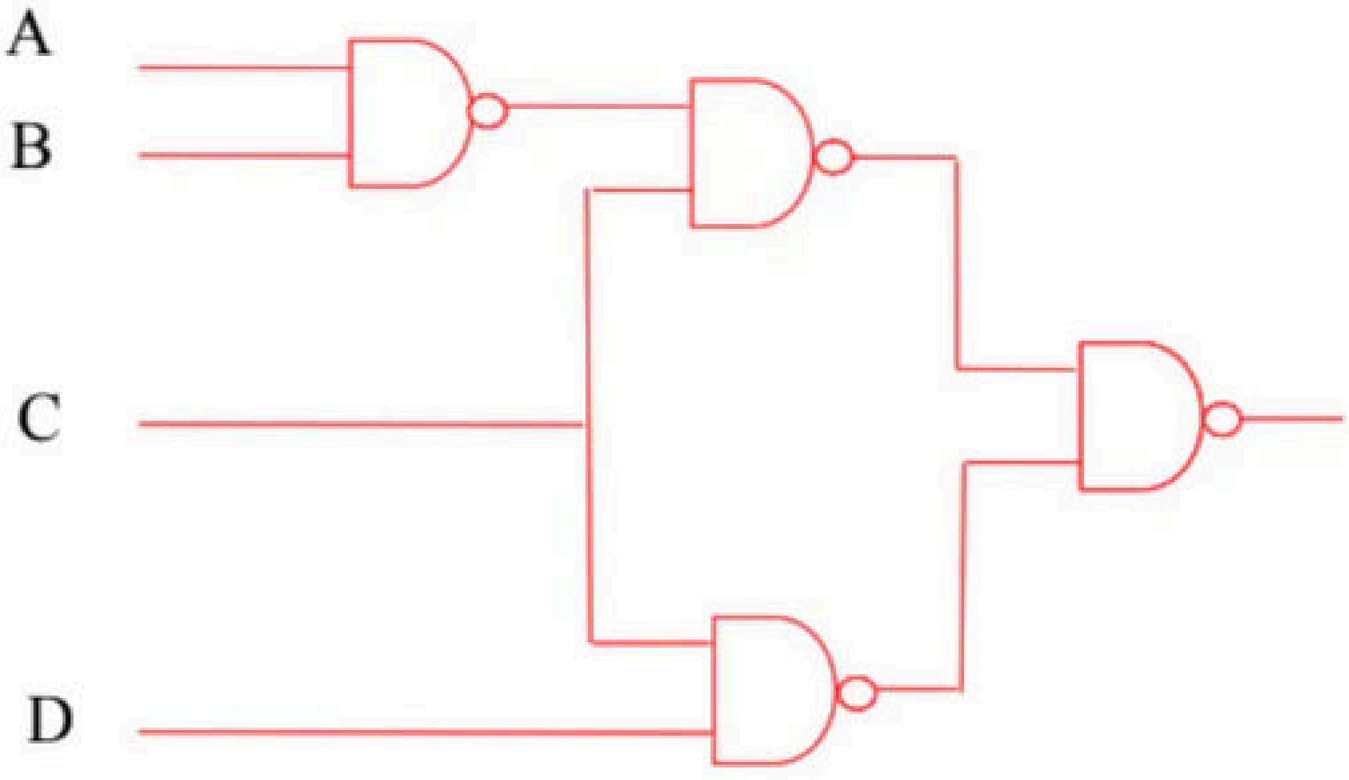
(d) NOR



106. The logic expression for the output of the circuit shown in figure below is:

(a) $\overline{A}C + \overline{B}C + CD$ (b) $A\overline{C} + B\overline{C} + \overline{C}D$

(c) $ABC + \overline{C}\overline{D}$ (d) $\overline{A}\overline{B} + \overline{B}\overline{C} + \overline{C}\overline{D}$



107. Which of the following operations is commutative but not associative?

(a) AND (b) OR

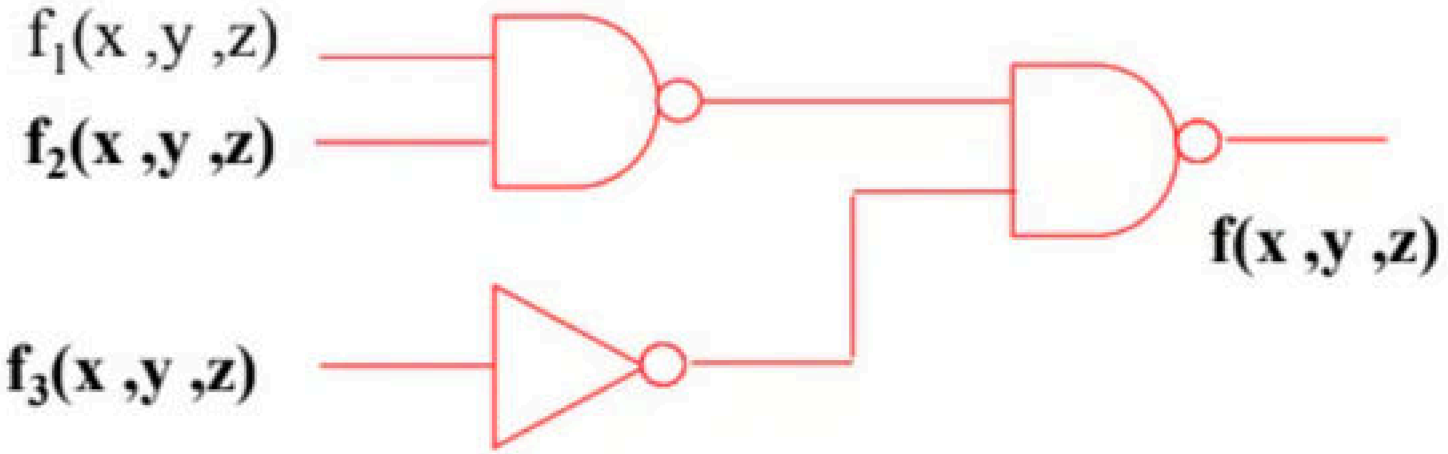
(c) NAND (d) EX-OR

108. Which of the following expression is not equivalent to $\overline{x}$?

(a) x NAND x (b) x NOR x

(c) x NAND 1 (d) x NOR 1

109. Consider the following logic circuit whose inputs are functions f_1, f_2, f_3 and output is f.



Given that

$f_1(x, y, z) = \sum(0,1,3,5)$

$f_2(x, y, z) = \sum(6,7)$

$f(x, y, z) = \sum(1,4,5)$

f_3 is

(a) $\sum(1,4,5)$ (b) $\sum(6,7)$

(c) $\sum(0,1,3,5)$ (d) None of the above

110. Consider the following circuit.

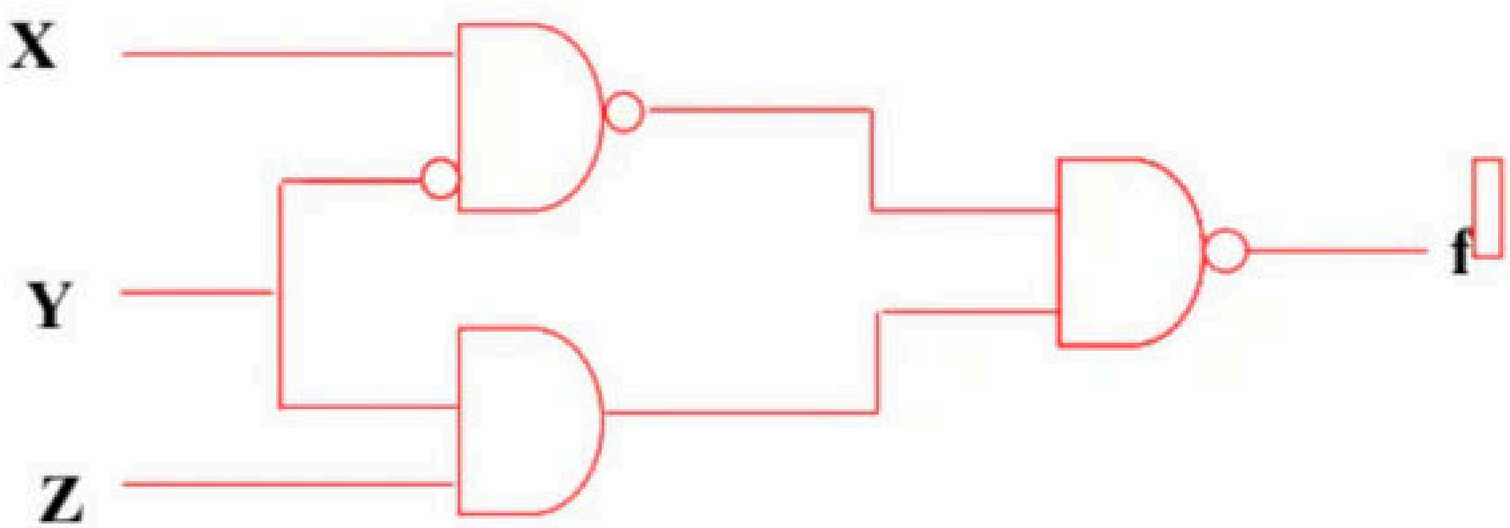
Which one of the following is TRUE?

(a)f is independent of X

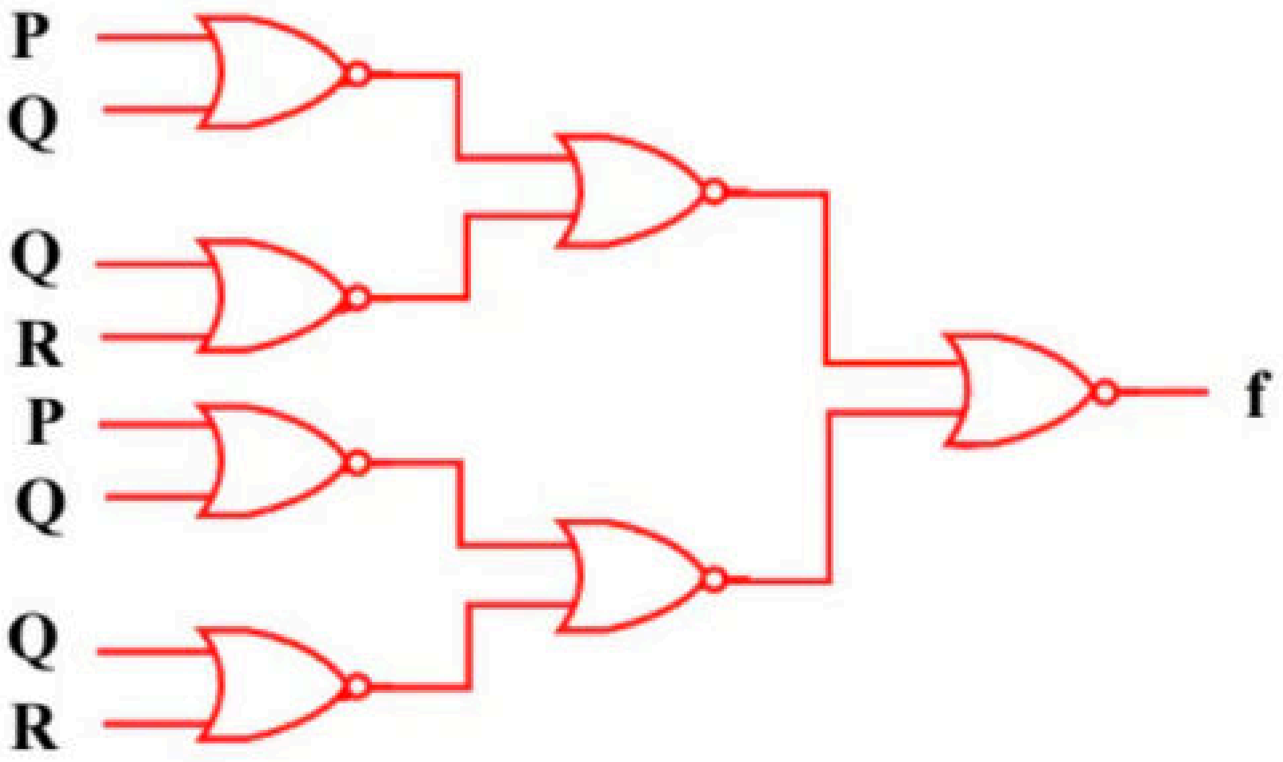
(b)f is independent of Y

(c) f is independent of Z

(d)None of X, Y, Z is redundant



111. What is the Boolean expression for the output f of the combinational logic circuit of NOR gates given below?

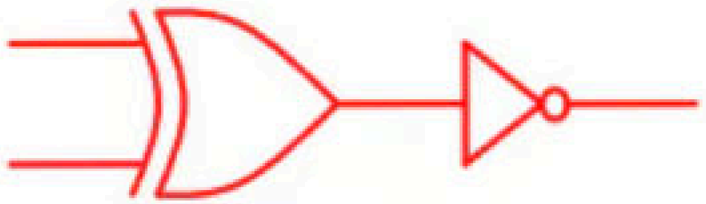


(a) $\overline{Q + R}$ (b) $\overline{P + Q}$

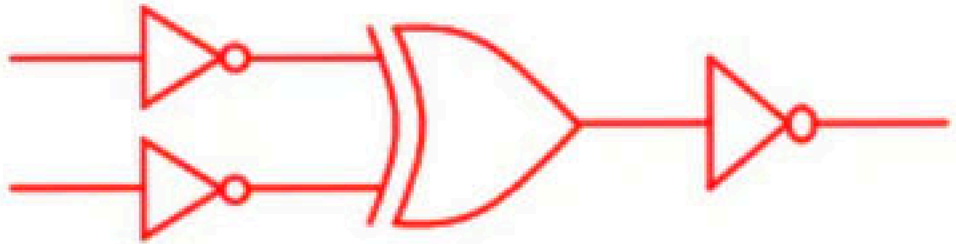
(c) $\overline{P + R}$ (d) $\overline{PR + Q}$

112. Which one of the following circuits is NOT equivalent to a 2-input XNOR (exclusive NOR) gate?

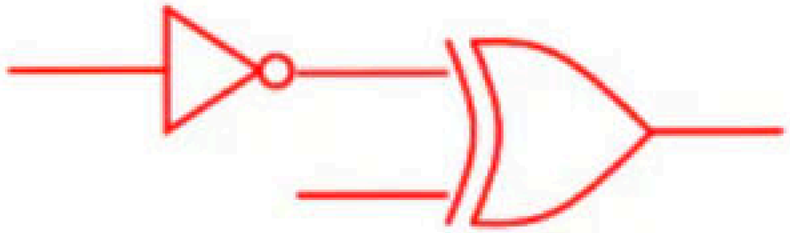
(a)



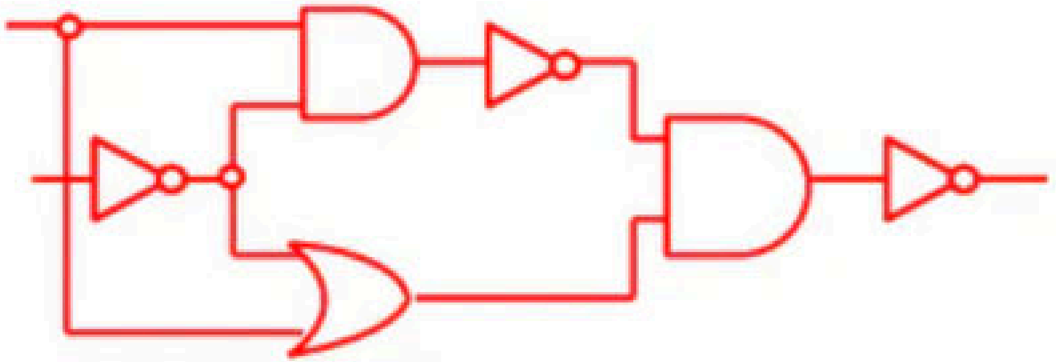
(b)



(c)



(d)



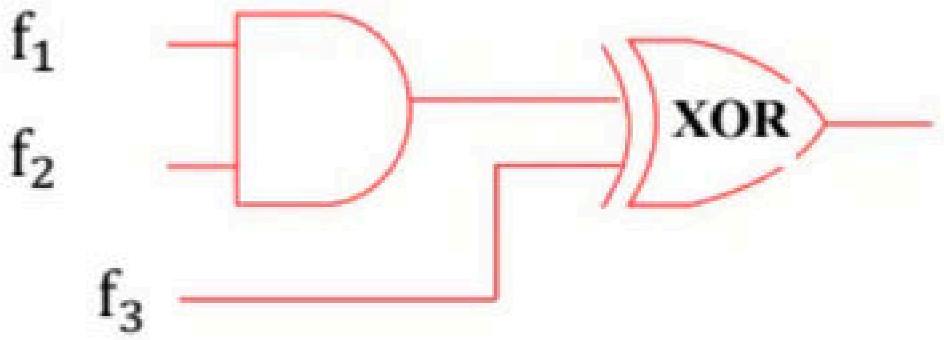
113. Which one of the following expressions does **NOT** represent exclusive NOR of x and y?

(a) $xy + x'y'$ (b) $x \oplus y'$

(c) $x' \oplus y$ (d) $x' \oplus y'$

114. Consider three 4-variable functions f_1, f_2 and f_3 which are expressed in sum- of- minterms as

$$f_1 = \sum(0,2,5,8,14)$$
$$f_2 = \sum(2,3,6,8,14,15)$$
$$f_3 = \sum(2,7,11,14)$$



For the following circuit with one AND gate and one XOR gate, the output function f can be expressed as:

(a) $\sum(7,8,11)$ (b) $\sum(2,14)$

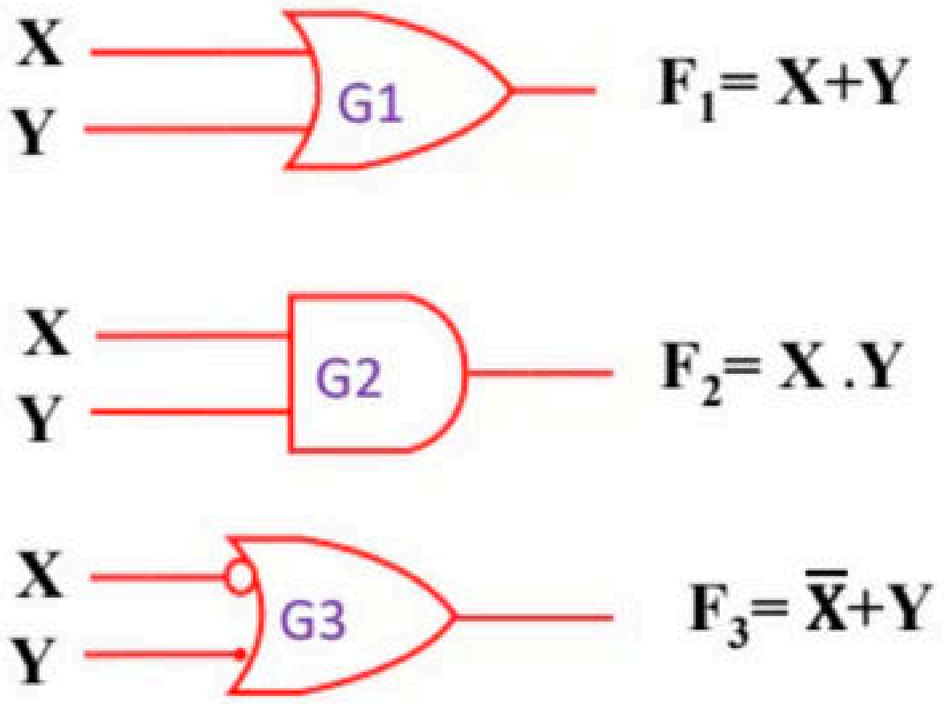
(c) $\sum(2,7,8,11,14)$ (d) $\sum(0,2,3,5,6,7,8,11,14,15)$

115. A 3-input majority gate is defined by the logic function $M(a, b, c) = ab + bc + ca$. Which one of the following gates is represented by the function $M\left(\overline{M(a, b, c)}, M(a, b, \bar{c}), c\right)$?

(a) 3-input NAND gate
(b) 3-input XOR gate
(c) 3-input NOR gate
(d) 3-input XNOR gate

116. A universal logic gate can implement any Boolean function by connecting sufficient number of them appropriately. Three gates are shown.

Which one of the following statements is TRUE?



(a) Gate 1 is a universal gate

(b) Gate 2 is a universal gate

(c) Gate 3 is a universal gate

(d) None of the gates shown is a universal gate

117. A Boolean function f of two variables x and y is defined as follows:

$f(0,0) = f(0,1) = f(1,1) = 1; f(1,0) = 0$

Assuming complements of x and y are not available, a minimum cost solution for realizing f using only 2-input NOR gates and 2-input OR gates (each having unit cost) would have a total cost of

(a) 1 unit (b) 4 units

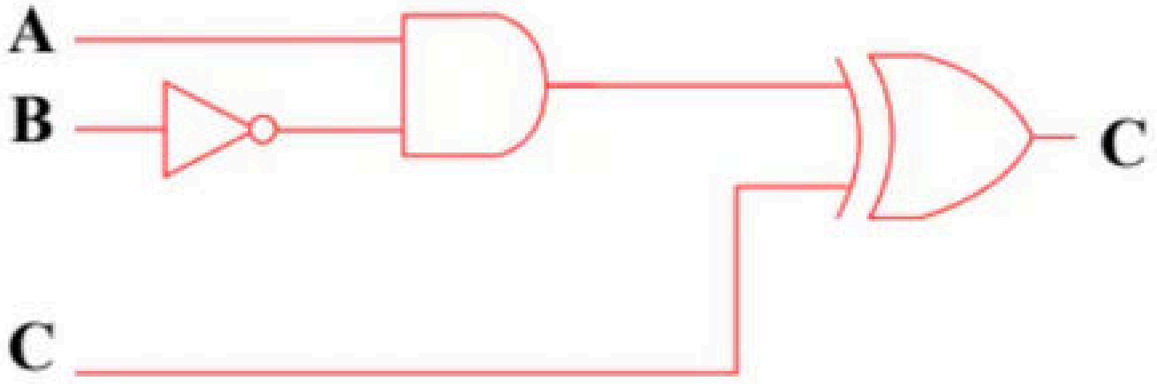
(c) 3 units (d) 2 units

118. The complete set of only those Logic Gates designated as Universal Gates is

(a) NOT, OR and AND gate
(b) XNOR, NOR and NAND gate
(c) NOR and NAND gate
(d) XOR, NOR and NAND gate

119. All the logic gates shown in the figure have a propagation delay of 20 ns.

Let A = C = 0 and B=1 until time t = 0. At t= 0, all the inputs flip (i.e., A = C = 1 and B = 0) and remain in that state. For t >0, output Z= 1 for a duration (in ns) of



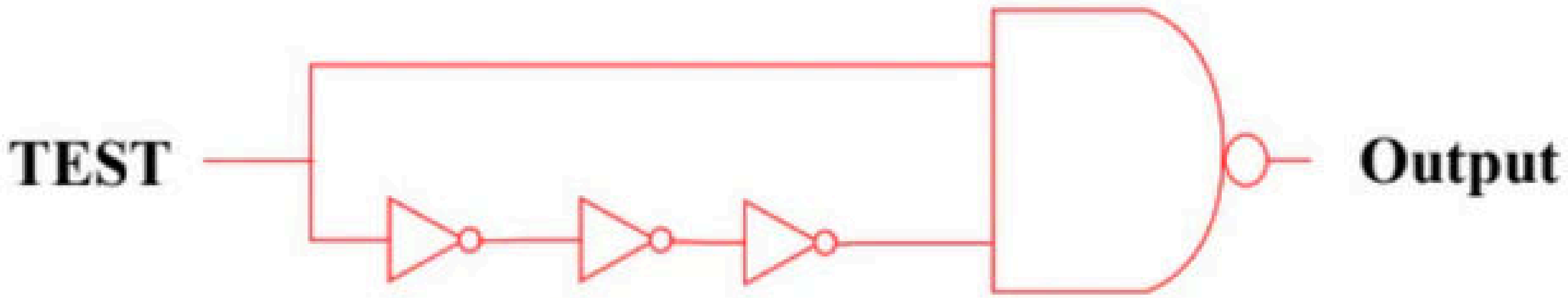
120. Consider the logic circuit with input signal TEST shown in the figure. All gates in the figure shown have identical non-zero delay. The signal TEST which was at logic LOW is switched to logic HIGH and maintained at logic HIGH. The output

(a) stays HIGH throughout

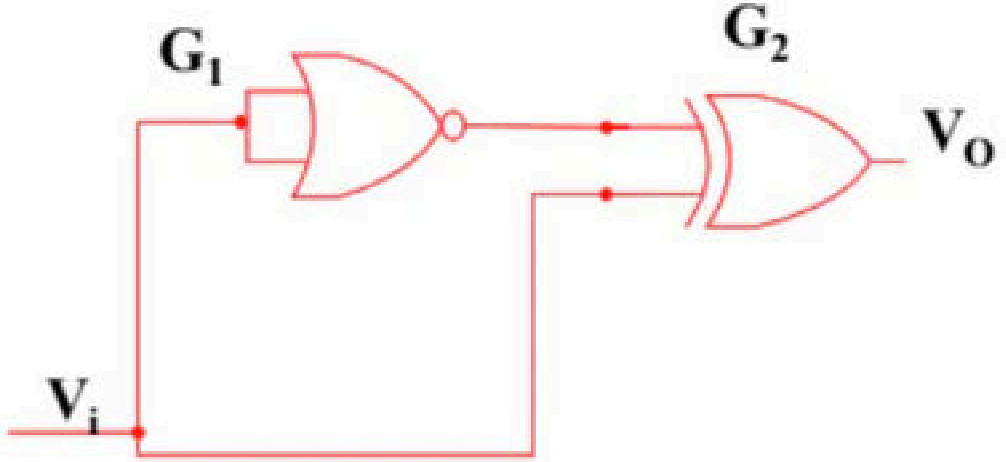
(b) stays LOW throughout

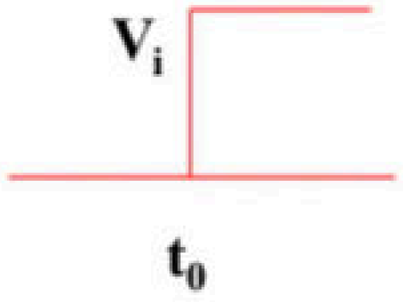
(c) pulses from LOW to HIGH to LOW

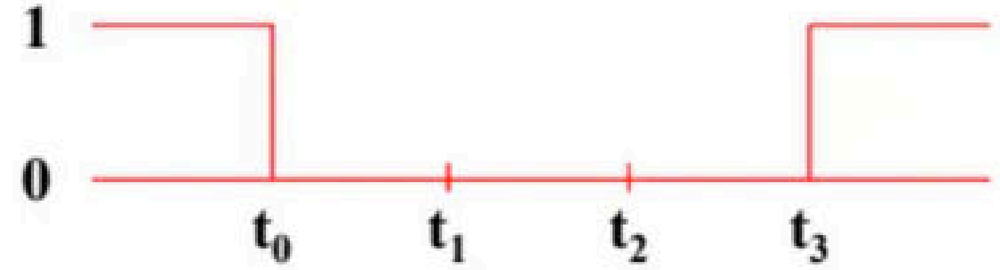
(d) pulses from HIGH to LOW to HIGH

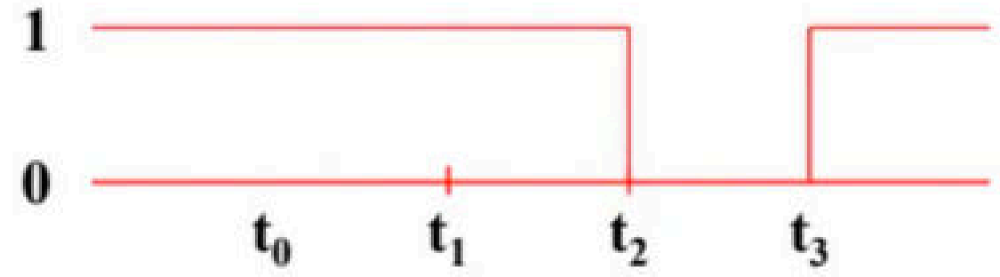


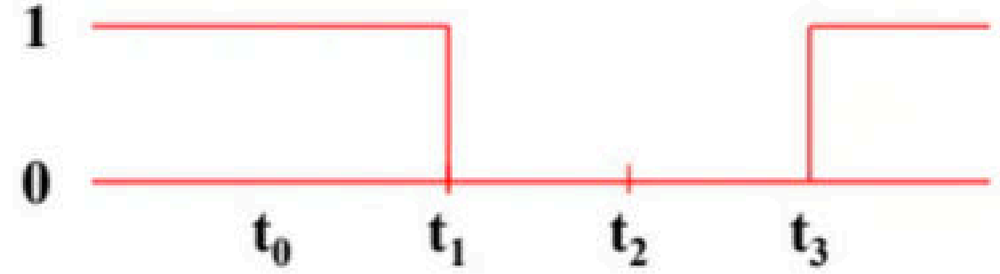
121. The gates G_1 and G_2 in figure have propagation delays of 10nsec and 20nsec respectively. If the input V_i makes an abrupt change from logic 0 to 1 at time $t = t_0$ then the output waveform V_0 is

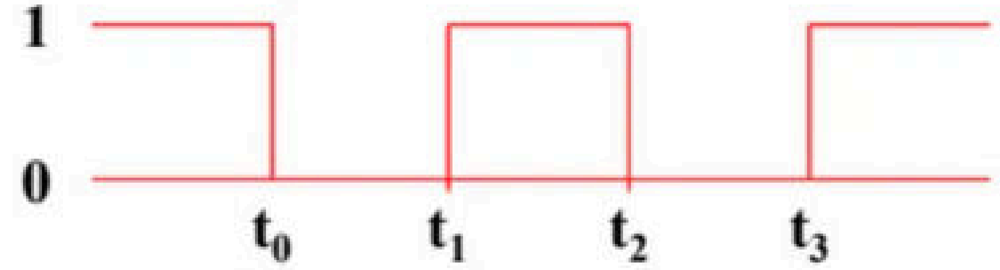




(a)


(b)


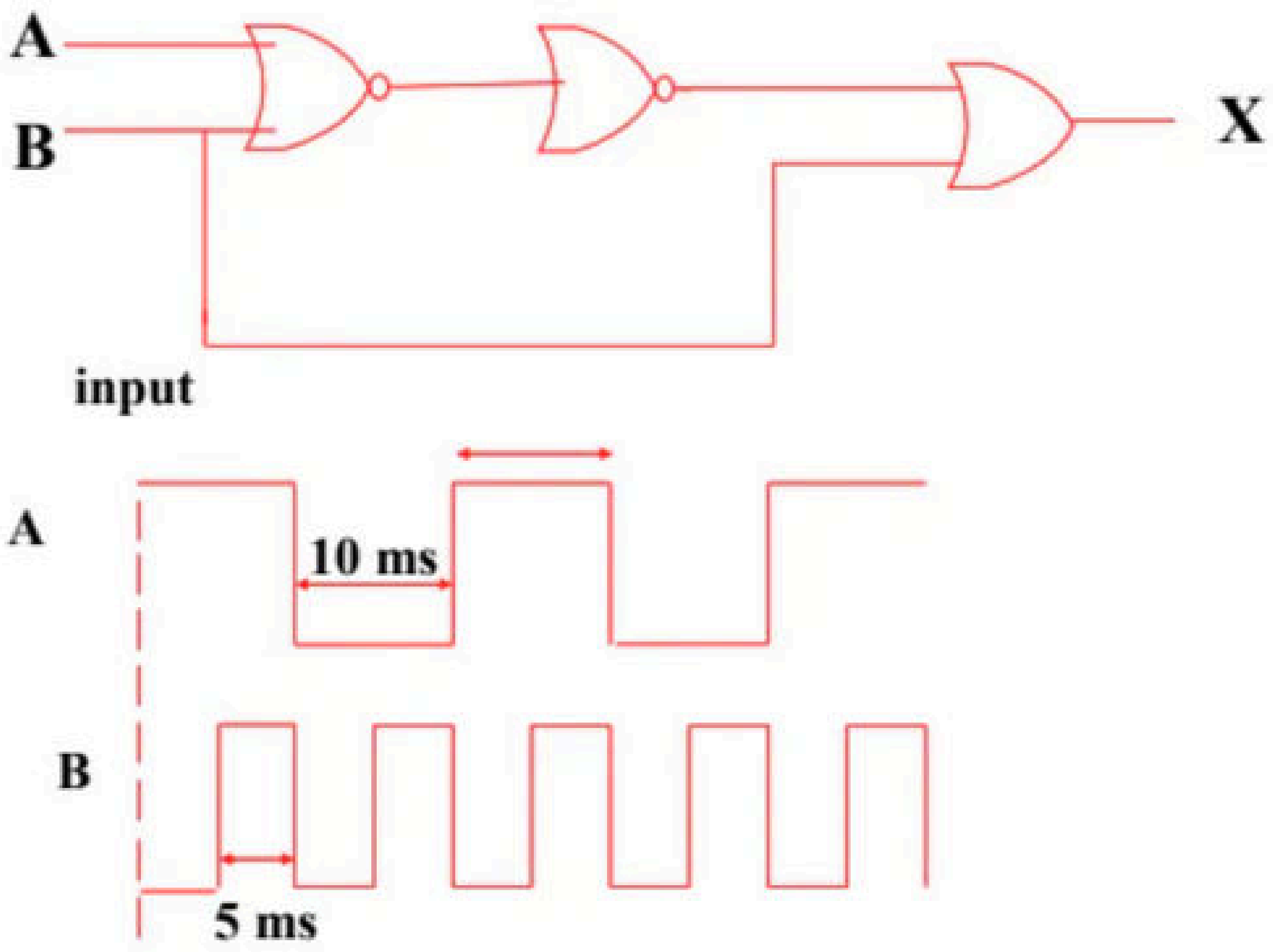
(c)


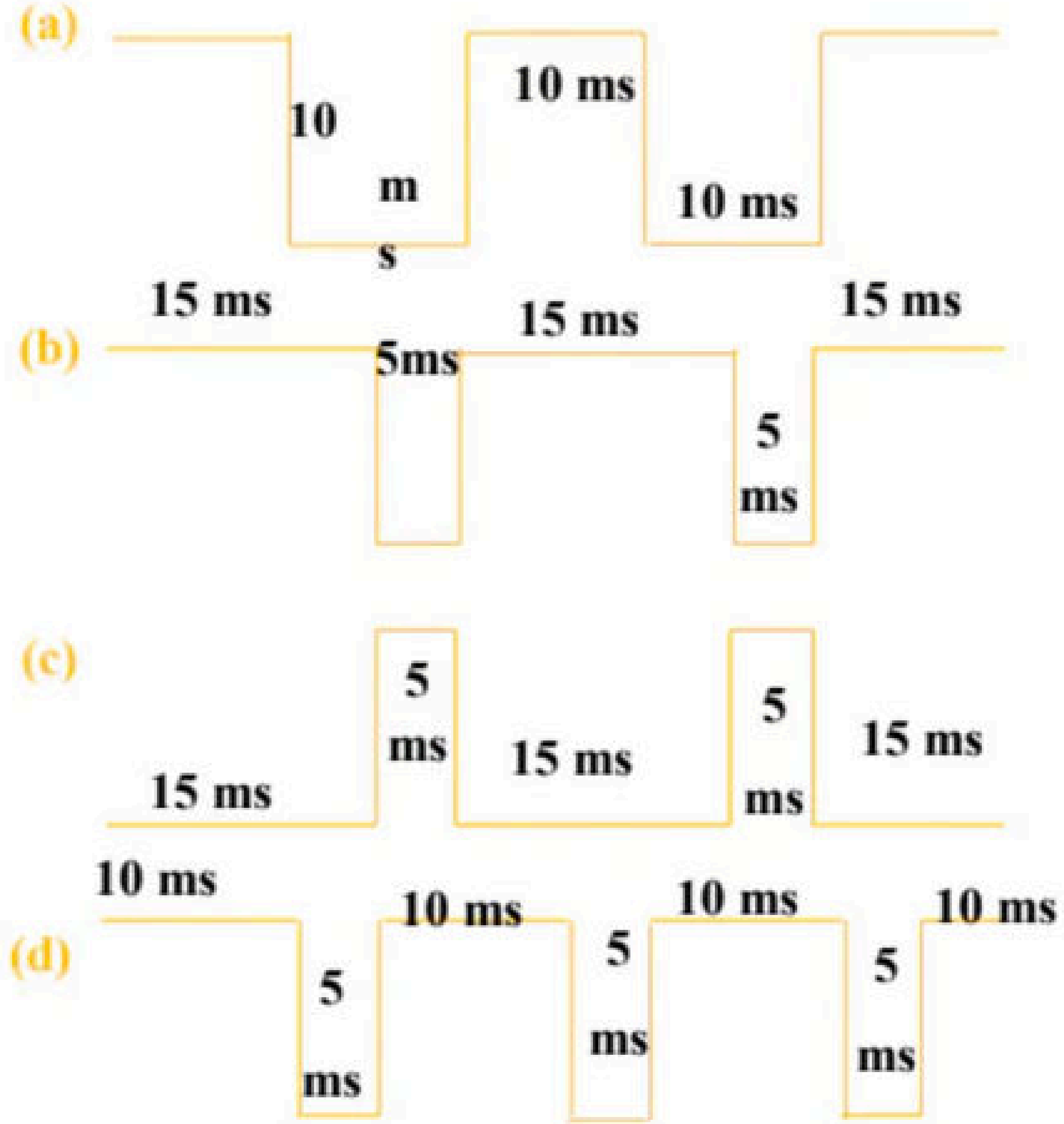
(d)


122. Which one of the following is equivalent to AND – OR realization

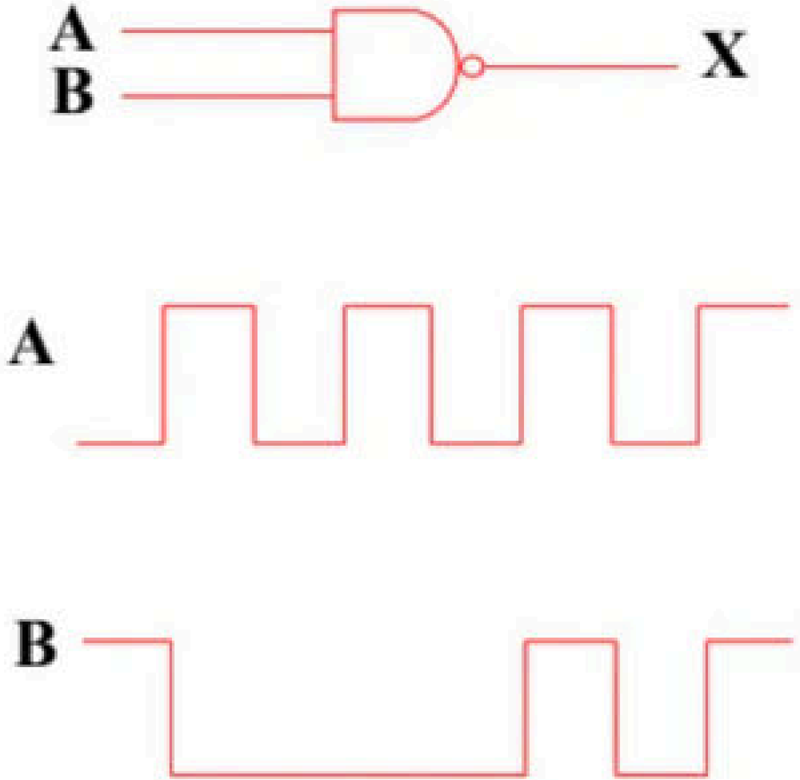
(a) NAND – NOR realization
(b) NOR – NOR realization
(c) NOR – NAND realization
(d) NAND – NAND realization

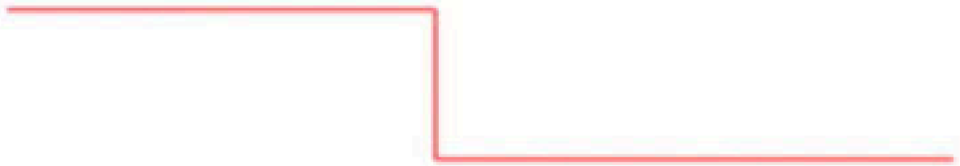
123. The output (x) waveform for the below combinational circuit for the inputs at A and B (waveform shown in the figure) will be.

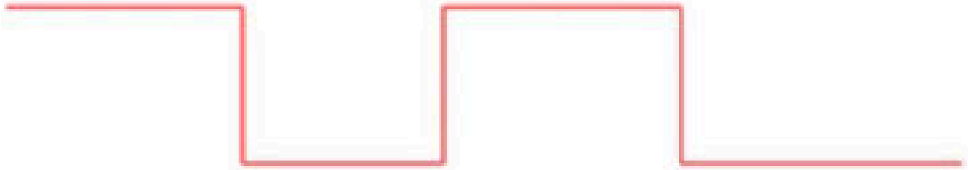




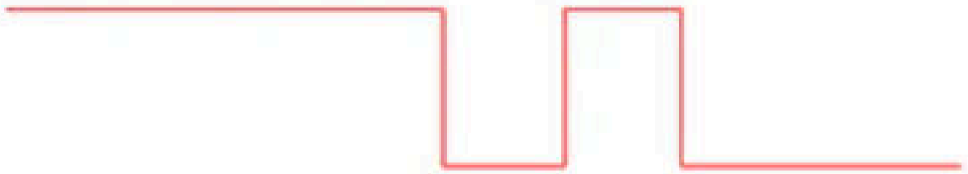
124. The given figure shows a NAND gate with input waveforms A and B The correct output waveform X of the gate is.



(a) 

(b) 

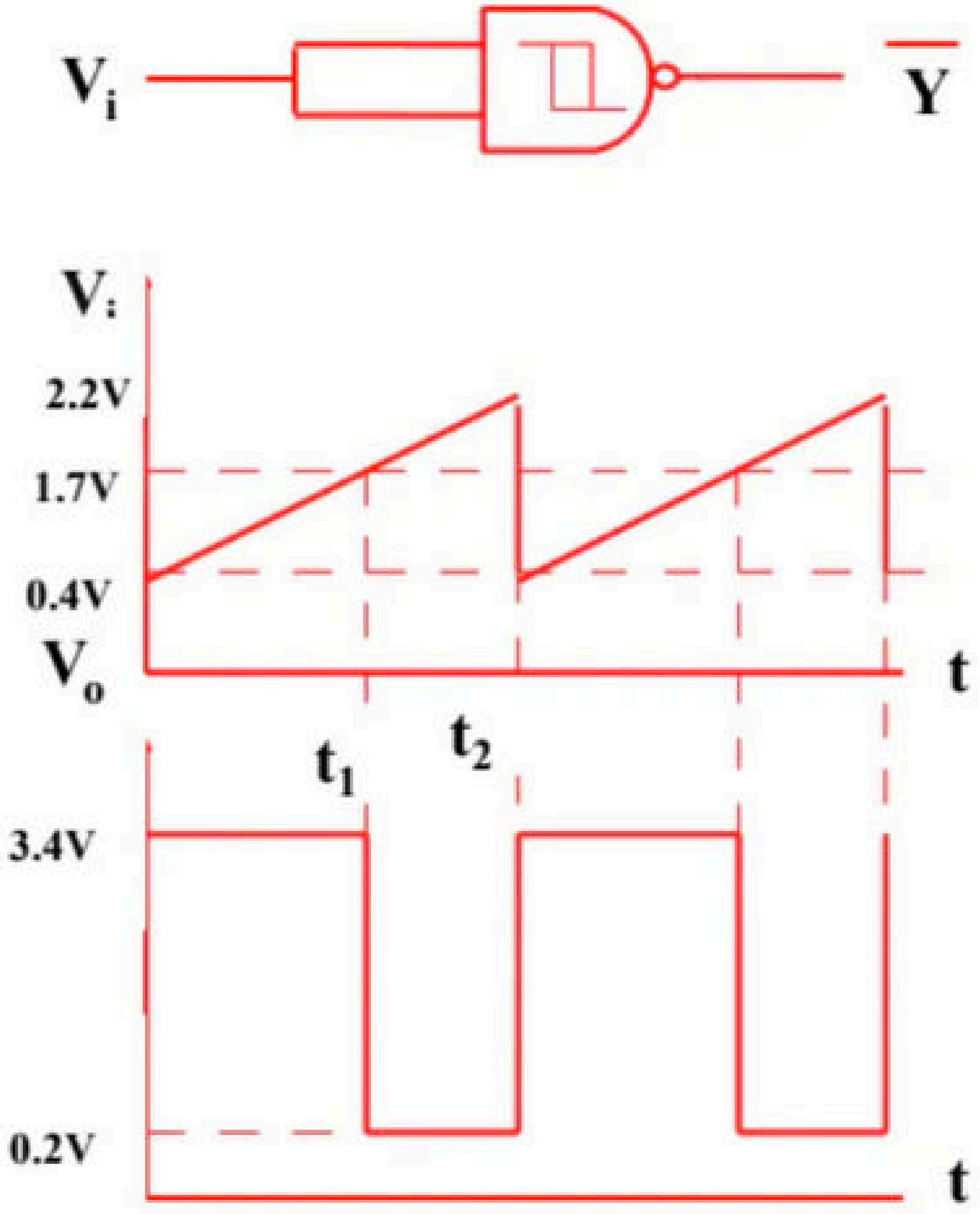
(c) 

(d) 

125. The input waveform V_i and the output waveform V_o of a Schmitt NAND as shown in the given figures. The duty cycle of the output waveform will be

(a) 100% (b) 85.5%

(c) 72.2% (d) 25%



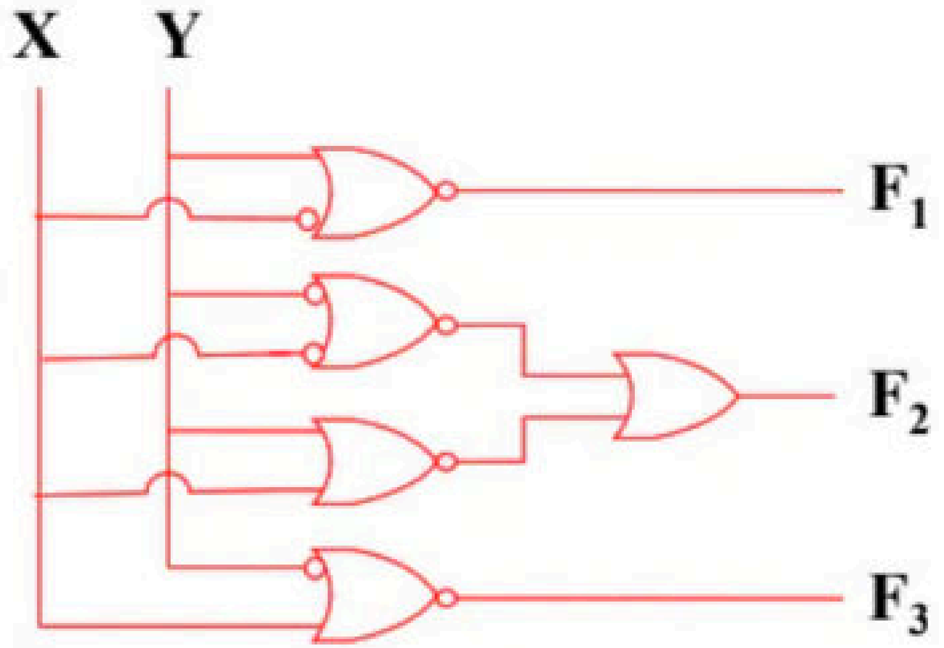
126. The circuit shown in the given figure is

(a) An Adder circuit

(b) A subtractor circuit

(c) A Comparator circuit

(d) A Parity generator circuit



127. Assume that only x and y logic inputs are available, and their complements $\overline{x}$ and $\overline{y}$ are not available. What is the minimum number of 2-input NAND gates required to implement $x \oplus y$?

(a) 2 (b) 3

(c) 4 (d) 5

128. The output of a two level AND-OR gate network is F. What is the output when all the gates are replaced by NOR gates?

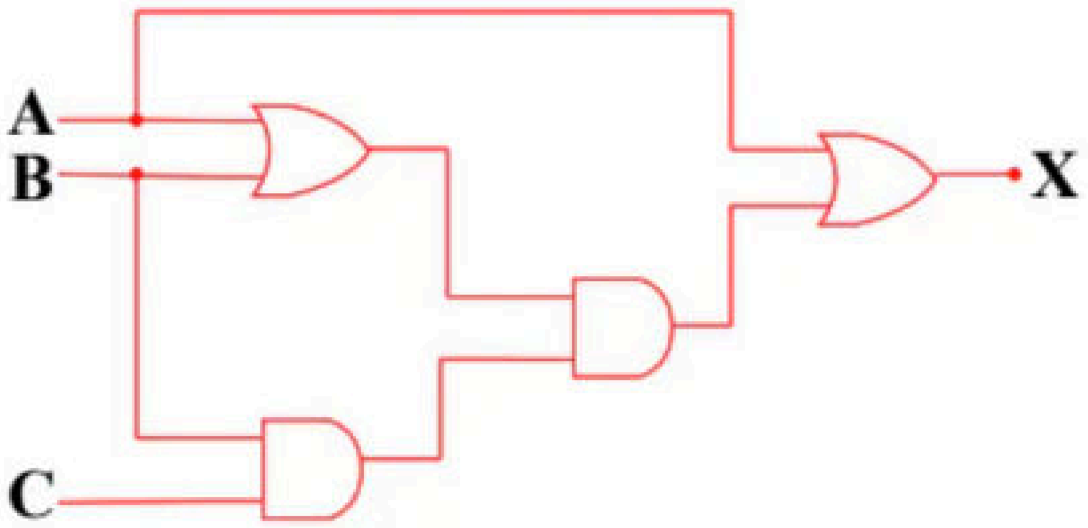
(a) F (b) $\overline{F}$

(c) F^D (d) $\overline{F}^D$

129. For the logic circuit given below, what is the simplified Boolean function?

(a) X = AB + C (b) X = BC + A

(c) X = AB + AC (d) X = AC + B



130. Which of the following are universal gates?

1. NAND 2. NOR 3.XOR

Select the correct answer from the codes given below:

(a) 1 and 2 only (b) 1 and 3 only

(c) 2 and 3 only (d) 1, 2 and 3

131. In NOR-NOR Configuration, the minimum number of NOR gates needed to implement the switching function $X + X\overline{Y} + X\overline{Y}Z$ is.

(a) 5
(b) 3
(c) 2
(d) 0

132. Which of the following are universal gates?

1\. AND 2. NAND 3.OR 4.NOR 5.NOT

(a) 1, 2, 3, 4 and 5 (b) 1, 3 and 4 only

(c) 2, 3 and 5 only (d) 2 and 4 only

133. The logic function; Out = ab + bc + ca defines:

1. The output of a 3-input XOR gate

2. The output of a 3-input majority gate

3. The sum output of a full adder

4. The carry output of a full adder

(a) 1 and 2 (b) 2 and 3

(c) 3 and 4 (d) 2 and 4

134. The minimum number of NAND gates required to implement $A + A\overline{B} + A\overline{B}C$ is

(a) zero (b) 1

(c) 4 (d) 7

135. The minimum number of gates required to realize the function $A\,B + \overline{C}$ (using NAND gates only) is

(a) 2 (b) 3

(c) 4 (d) 6

136. Match List-I with List-II and select the correct answer using the codes given below the Lists:

List-I (Boolean identity)	**List-II (Boolean expression)**
A. $Y.(Y+Z)$	1. $(X+Y)(X+Z)$
B. $Y+\overline{Y}.Z$	2. (Y)
C. $Y \oplus Z$	3. $(Y+Z)$
D. $X+Y.Z$	4. $(Y+Z).(\overline{Y}+\overline{Z})$

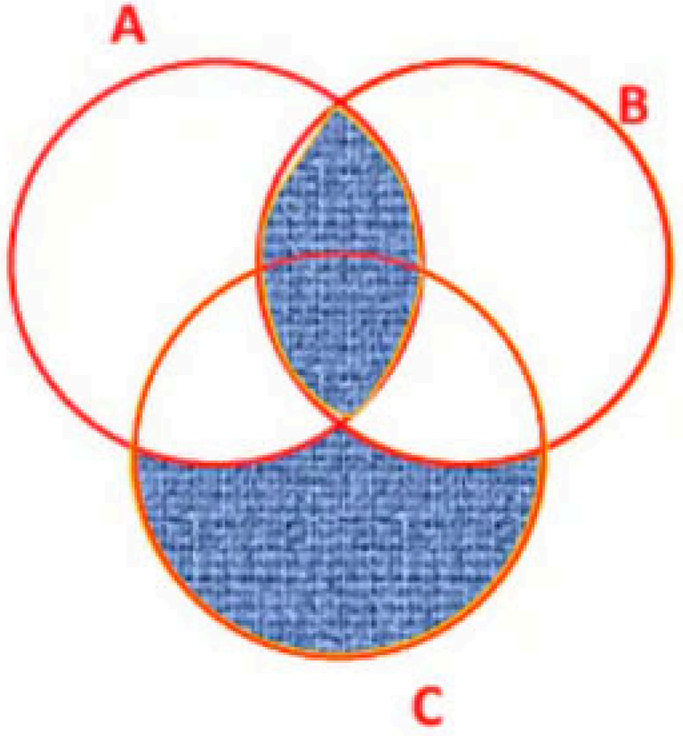
Codes:

	A	**B**	**C**	**D**
(a)	1	2	4	3
(b)	2	3	1	4
(c)	2	3	4	1
(d)	3	2	1	4

137. The Boolean expression for the shaded area in the Venn diagram shown is.

(a) $A+\overline{B}+C$ (b) $AB+\overline{A}BC$

(c) $A\overline{B}C+\overline{A}BC$ (d) $AB+\overline{A}\,\overline{B}C$



138. Consider the following expressions:

1. $Y = f(A, B, C, D) = \sum(1,2,4,7,8,11,13,14)$
2. $Y = f(A, B, C, D) = \sum(3,5,7,10,11,12,13,14)$
3. $Y = f(A, B, C, D) = \prod(0,3,5,6,9,10,12,15)$
4. $Y = f(A, B, C, D) = \prod(1,2,4,6,8,9,15)$

Which of these expressions are equivalents of the expression

$Y = A \oplus B \oplus C \oplus D$

(a) 1 and 2 (b) 1 and 4

(c) 2 and 3 (d) 1and 3

139. Consider the operations

$$f(X,Y,Z) = XY'Z + XY' + Y'Z' \text{ and } g(X,Y,Z) = X'YZ + X'YZ' + XY$$

Which one of the following is correct?

(A) Both {f} and {g} are functionally complete

(B) Only {f} is functionally complete

(C) Only {g} is functionally complete

(D) Neither {f} nor {g} is functionally complete

140. Consider the Boolean operator # with the following properties:

$x \# 0 = x, x \# 1 = \bar{x}, x \# x = 0$ *and* $x \# \bar{x} = 1$. Then x # y is equivalent to

(A) $x\bar{y} + \bar{x}y$ (B) $x\bar{y} + \bar{x}\bar{y}$

(C) $x\bar{y} + xy$ (d) $xy + \bar{x}\bar{y}$

141. Which one of the following is NOT a valid identity?

(A) $(x \oplus y) \oplus z = x \oplus (y \oplus z)$

(B) $x \oplus y = (xy + x'y')'$

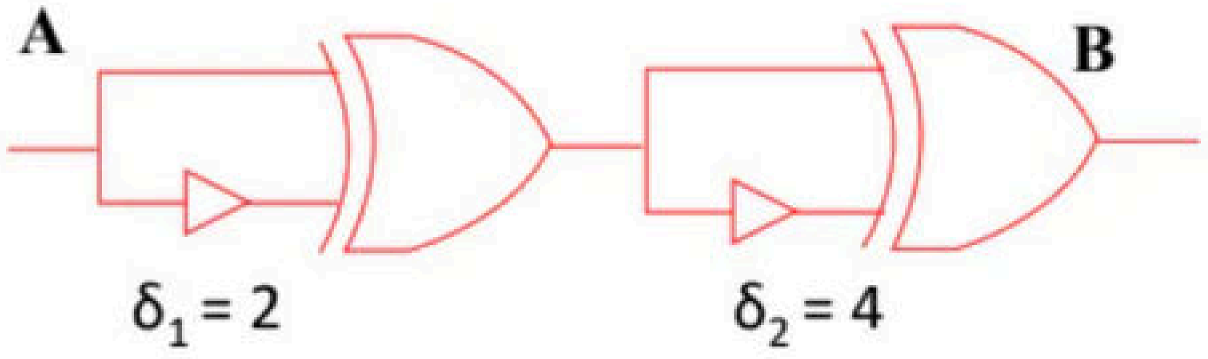
(C) $(x + y) \oplus z = x \oplus (y + z)$

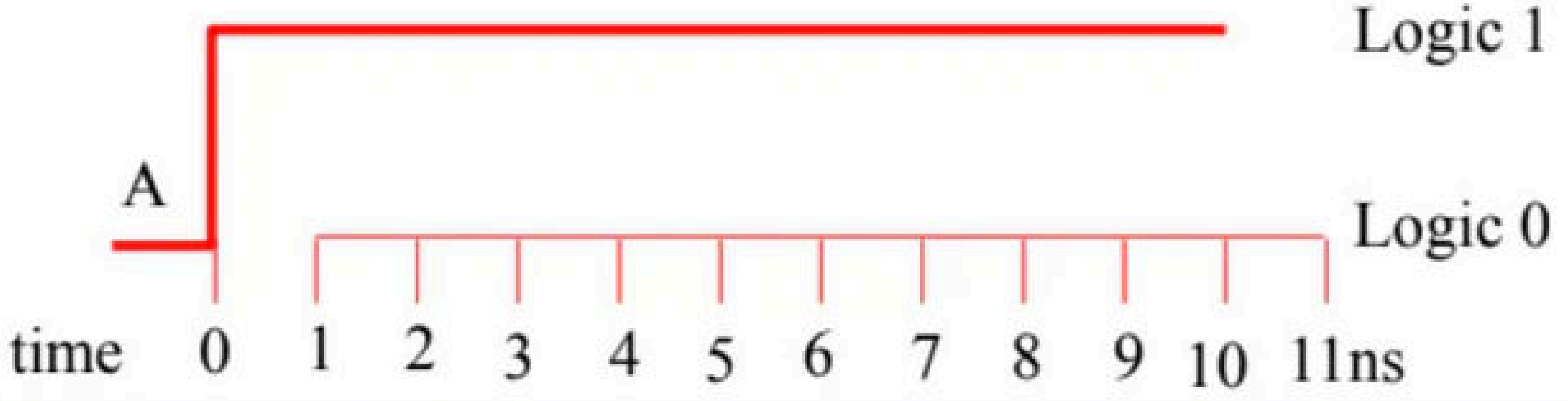
(D) $(x \oplus y) = x + y, \text{if } xy = 0$

142. Consider the following circuit composed of XOR gates and non-inverting buffers The non-inverting buffers have delays δ_1= 2ns and δ_2= 4ns as shown in the figure. Both XOR gates and all wires have zero delay. Assume that all gate inputs, outputs and wires are stable at logic level 0 at time 0. If the following waveform is applied at input A, how many transition(s) (change of logic levels) occur(s) at B during the interval from 0 to 10 ns?

(a) 1 (b) 2

(c) 3 (d) 4





143. For a digital circuit having 4 inputs , 0 is represented by 0000, 1 by 0001, …, 9 by 1001.

A combinational circuit is to be designed which takes these 4 bits as input and output is 1 if the digit ≥ 5, and 0 otherwise. If only AND, OR and NOT gates may be used, what is the minimum number of gates required?

(a) 2 (b) 3

(c) 4 (d) 5

144. What is the minimum number of gates required to implement the Boolean function $(AB+C)$ if we have to use only 2-input NOR gates?

(a) 2 (b) 3

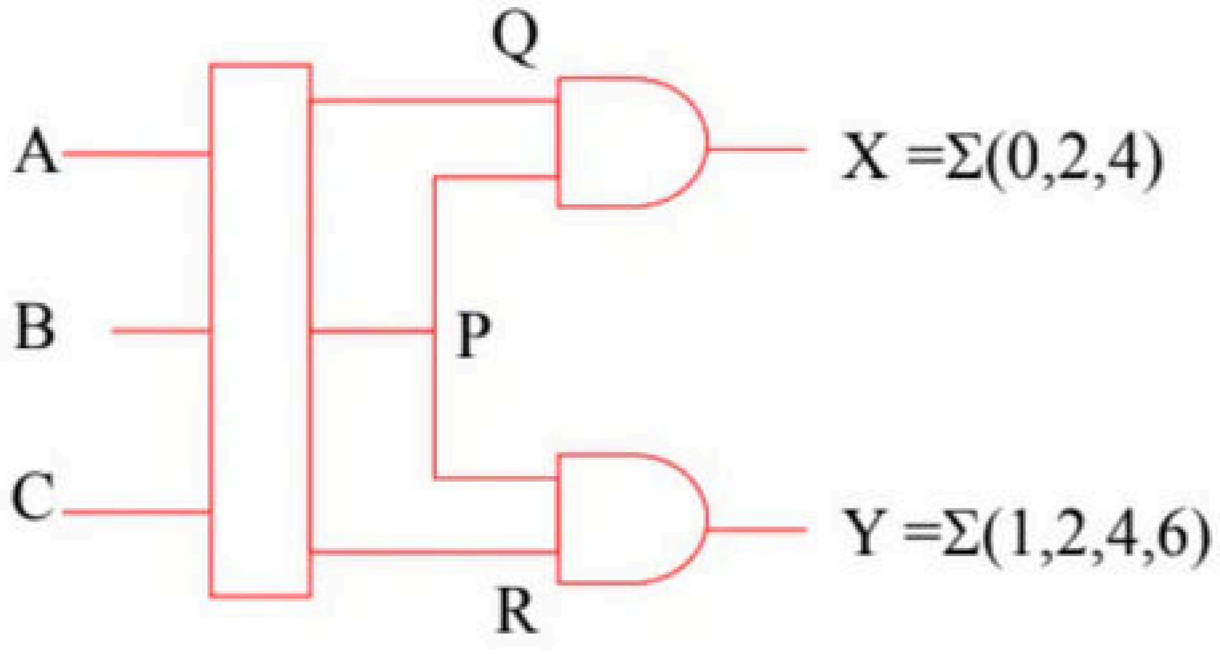
(c) 4 (d) 5

145. The sum of products form can be realized by using ------- logic

(a) NAND-NAND (b) AND-OR

(c) Either 1 or 2 (d) None

146. Given a combinational network with three inputs A, B and C, three intermediate output, P, Q and R, and two output $X = P.Q = \Sigma(0, 2, 4)$ and $Y = P.R = \Sigma(1, 2, 4, 6)$ as shown below, find the smallest function P (containing minimum number of minterms that can produce the output X and Y).



(a) $\Sigma(2, 4)$ (b) $\Sigma(0, 1, 2, 4, 6)$

(c) $\Sigma(3, 5, 7)$ (d) $\Sigma(1, 2, 6)$

147. What is the maximum number of different Boolean functions involving *n* Boolean V variables?

(A) n^2 (B) 2^n

(C) 2^{2^n} (D) 2^{n^2}

148. The dual of a Boolean function $F(X_1, X_2, \ldots\ldots\ldots X_n)$, written as F^D, is the same Expression as that of F with + and swapped. F is said to be self-dual if $F = F^D$. The number of self-dual functions with n Boolean variables is

(A) 2n (B) 2n-1

(C) 2^{2^n} (D) $2^{2^{n-1}}$

149. The SOP form of logical expression is most suitable for designing logic circuit using only

(a) NOR gates (b) NAND gates

(c) AND gates (d) X-OR gates

150. The SOP (sum of products) form of a Boolean function is $\sum(0,1,3,7,11)$, where inputs are A, B, C, D (A is MSB, and D is LSB). The equivalent minimized expression of the function is

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

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

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

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

151. The POS form of logical expression is most suitable for designing logic circuits using only

(a) X-OR gates (b) AND gates

(c) NAND gates (d) NOR gates

152. The sum of products form can be realized by using ------- logic

(a) NAND-NAND (b) AND-OR

(c) Either 1 or 2 (d) None

153. The Maximum number of different Boolean functions that can be implemented with '4' variable is

(a) 216 (b) 162

(c) 42 (d) 65536

154. The Number of switching functions of 3 variables is

(a) 8 (b) 64

(c) 128 (d) 256

155. For the Boolean expression $f = \bar{a}\bar{b}\bar{c} + \bar{a}b\bar{c} + a\bar{b}\bar{c} + abc + ab\bar{c}$ the minimized Product of Sum (POS) expression is

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

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

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

(d) $f = \bar{c} + abc$

156. The Boolean expression

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

can be minimized to

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

(b) $Y = \bar{A}\bar{B}\bar{C}D + BC\bar{D} + A\bar{B}\bar{C}D$

(c) $Y = \bar{A}BC\bar{D} + \bar{B}\bar{C}D + A\bar{B}\bar{C}D$

(d) $Y = \bar{A}BC\bar{D} + \bar{B}\bar{C}D + AB\bar{C}\bar{D}$

158. The number of distinct Boolean expression of 4 variables is

(a) 16 (b) 256

(c) 1024 (d) 65536

158. $Y = f(A, B) = \prod M\ (0,1,2,3)$ represents (M is max term)

(a)NOR Gate (b) NAND Gate

(c)OR Gate (d) a situation where output is independent of input.

159. With four Boolean variables how many Boolean expressions can be formed.

(a)16 (b) 256

(c)1024(1k) (d) 64k (64×1024)

160. Match List-I (Boolean Logic Function) with List-II (Inverse of Function) and select the correct answer using the codes given below the lists:

List-I	**List-II**
A. $ab + bc + ca + abc$	1. $\overline{a}\ (\overline{b} + \overline{c})$
B. $ab + \overline{a}\,\overline{b} + \overline{c}$	2. $\overline{a}\,\overline{b} + \overline{b}\,\overline{c} + \overline{ca}$
C. $a + bc$	3. $(a \oplus b)c$
D. $(\overline{a} + \overline{b} + \overline{c})(a + \overline{b} + \overline{c})(\overline{a} + \overline{b} + c)$	4. $abc + \overline{a}\,bc + ab\overline{c}$

Codes:

	A	**B**	**C**	**D**
(a)	3	2	1	4
(b)	2	3	1	4
(c)	3	2	4	1
(d)	2	3	4	1

161. The output of a two level AND-OR gate network is F. What is the output when all the gates are replaced by NOR gates?

(a) F (b) $\overline{F}$

(c) F^D (d) $\overline{F}^D$

162. The number of Boolean functions which can be generated with four variables is?

(a) 4 (b) 16

(c) 256 (d) 65,536

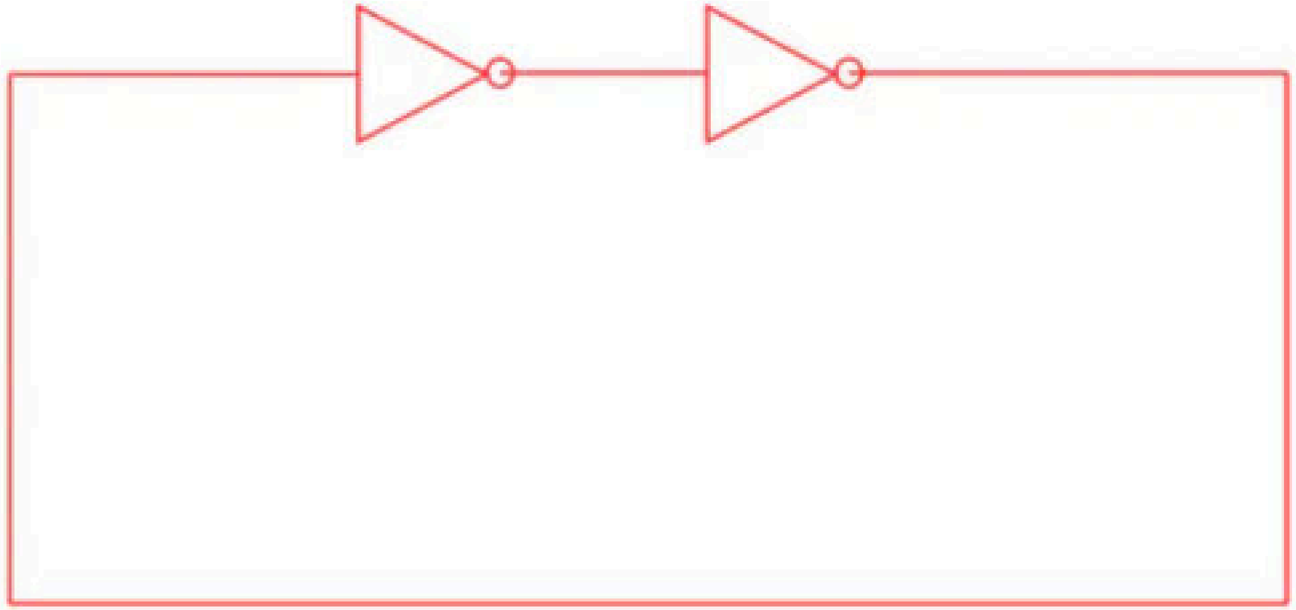
163. The digital circuit using two invertors as shown in the below figure acts as?

(a) a Bi-stable Multivibrator

(b) an Astable Multivibrator

(c) a Monostable Multivibrator

(d) an oscillator spectrum

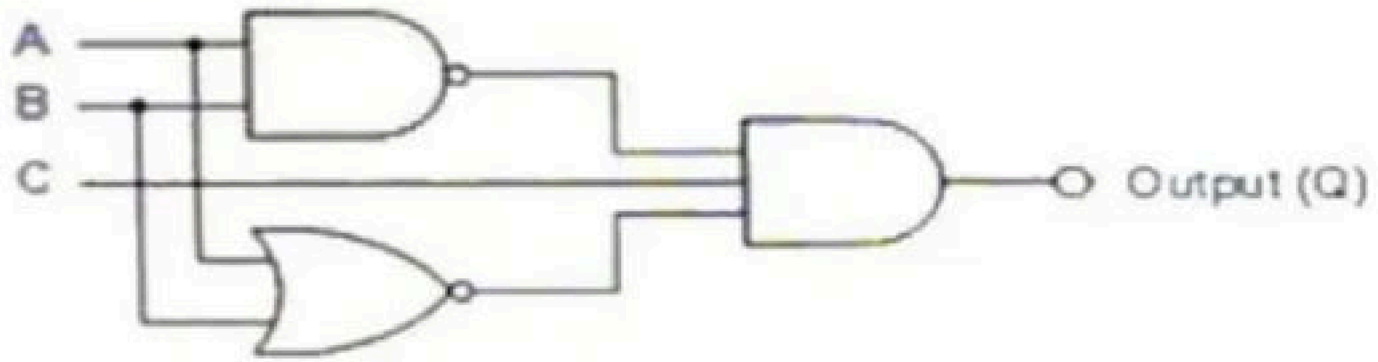


164.Consider a Boolean gate (D) where the output Y is related to the inputs A and B as $Y = A + \bar{B}$ where + denotes logical OR operation. The Boolean inputs '0' and '1' are also available separately Using instances of only D gates and inputs '0' and '1'__________ (select correct option(s))

GATE -22 (EC)

(a) NAND logic can be implemented
(b) OR logic cannot be implemented
(c) NOR logic can be implemented
(d) AND logic cannot be implemented

165. Consider the following logic circuit whose inputs are functions A, B, C and output is Q



Given that

$A(p, q, r, s) = \sum_m(0, 5, 6, 7, 11, 12)$

$B(p, q, r, s) = \prod_M(1, 2, 4, 7, 9, 12, 13, 15)$, and

$C(p, q, r, s) = \prod_M(0, 5, 6, 7, 13)$

Then $Q(p, q, r, s)$ is

(a) $\sum_m(1, 2, 4, 9, 15)$

(b) $\prod_M(1, 2, 4, 9, 15)$

(c) $\prod_M(0, 5, 6)$

(d) $\sum_m(1, 2, 4, 9)$

K- Map’s

1. The output expression for the Karnaugh map shown below is

(a) $B\overline{D} + BCD$ (b) $B\overline{D} + AB$

(c) $\overline{B}D + ABC$ (d) $B\overline{D} + ABC$

AB \ CD	00	01	11	10
00	0	0	0	0
01	1	0	0	1
11	1	0	1	1
10	0	0	0	0

2. Karnaugh map is used to

(a) minimize the number of flip-flops in a digital circuit

(b) minimize the number of gates only in a digital circuit

(c) minimize the number of gates and fan in a digital circuit

(d) Design gates

3. The output expression for the Karnaugh map shown below is

(a) $A + \overline{B}$ (b) $A + \overline{C}$

(c) $\overline{A} + \overline{C}$ (d) $\overline{A} + C$

A \ B C	00	01	11	10
00	1	0	0	1
01	1	1	1	1

4. If $F(A, B, C, D) = \prod M\,(0,1,3,4,5,7,9,11,12,13,14,15)$ is a maxterm representation of a Boolean function $f(A, B, C, D)$ where A is the MSB and D is the LSB. The equivalent minimized representation of this function is

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

(b) $A\bar{C}D + \bar{A}BD$

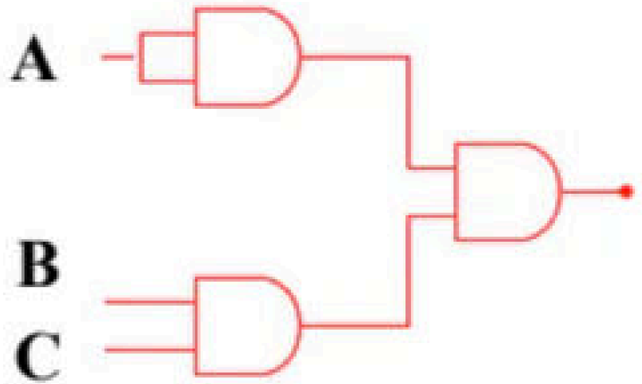
(c) $\bar{A}C\bar{D} + A\bar{B}\bar{D}$

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

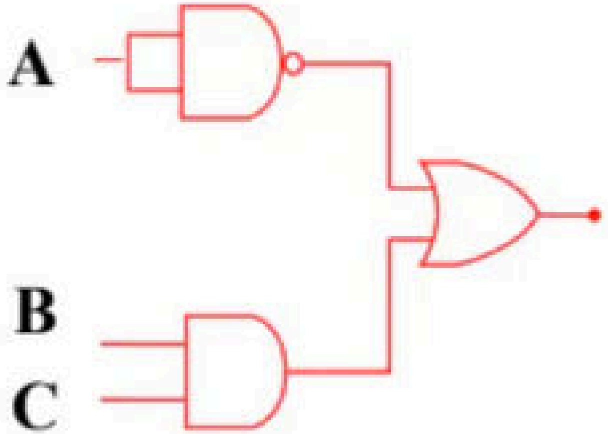
5. Which of the following logic circuits is a realization of the function F whose Karnaugh map is shown in figure?

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

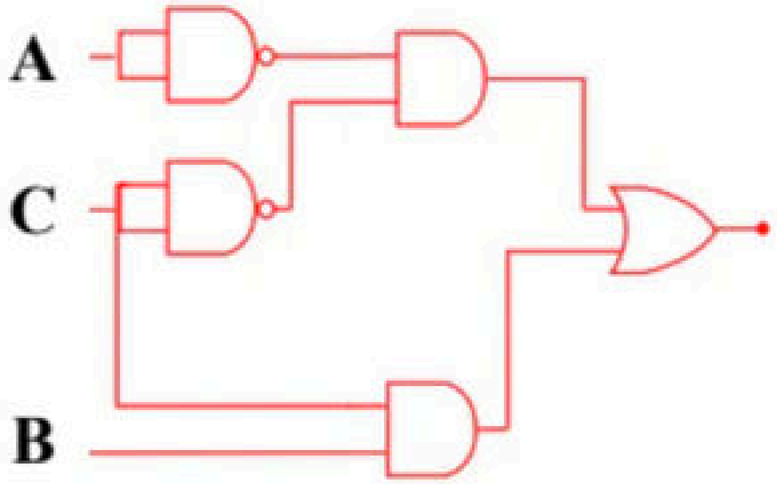
(a)



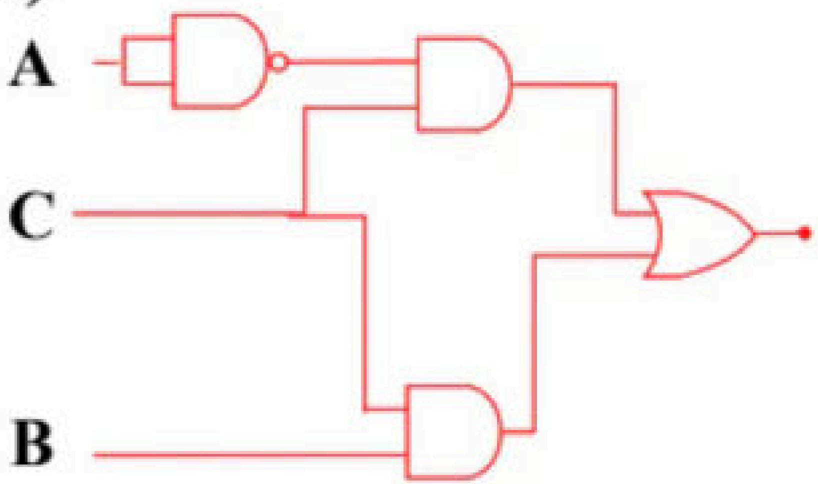
(b)



(c)



(d)



6. Statement for Linked Answer Questions

The following Karnaugh map represents a function F

X \ YZ	00	01	11	10
0	1	1	1	0
1	0	0	1	0

[i] A minimized form of the function F is

(a) $F = \overline{X}Y + YZ$ (b) $F = \overline{X}\,\overline{Y} + YZ$

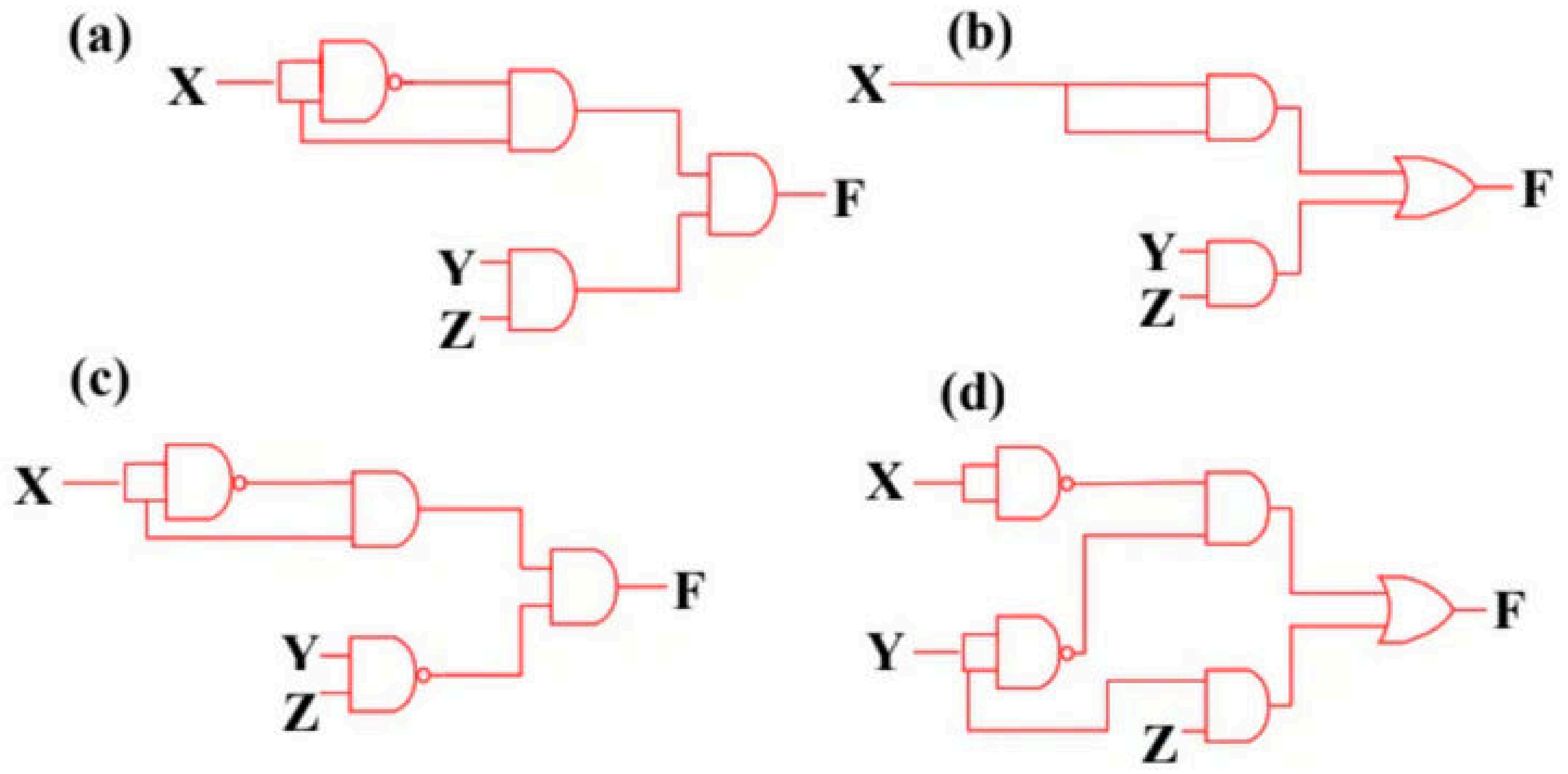
(c) $F = \overline{XY} + Y\overline{Z}$ (d) $F = \overline{XY} + \overline{Y}Z$

7. Statement for Linked Answer Questions

The following Karnaugh map represents a function F

X \ YZ	00	01	11	10
0	1	1	1	0
1	0	0	1	0

[ii] Which of the following circuits is a realization of the above function F?



8. The Boolean expression for the truth table shown is:

(a) $B(A + C)(\bar{A} + \bar{C})$

(b) $B(A + \bar{C})(\bar{A} + C)$

(c) $\bar{B}(A + \bar{C})(\bar{A} + C)$

(d) $\bar{B}(A + C)(\bar{A} + \bar{C})$

A	B	C	D
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	0

9. The Karnaugh map for a four variable Boolean function is given in figure. The correct Boolean sum of product is

(a) $PQRS + \overline{Q}S$ (b) $\overline{P}QR\overline{S} + \overline{Q}S$

(c) $PQR + Q\overline{S}$ (d) $PQRS + \overline{Q}$

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

10. The minimal sum-of-products expression for the logic function f represented by the given Karnaugh map is.

(a) $QS + P\bar{R}S + PQR + \bar{P}RS + \bar{P}Q\bar{R}$

(b) $\overline{QS} + \bar{P}R\bar{S} + \bar{P}\bar{Q}R + P\bar{R}\bar{S} + P\bar{Q}R$

(c) $\bar{P}R\bar{S} + \bar{P}\bar{Q}\bar{R} + P\bar{R}\bar{S} + P\bar{Q}R$

(d) $P\bar{R}S + PQR + \bar{P}RS + \bar{P}QR$

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

11. The minimal sum of products form of the Boolean expression

$$Y = \overline{P}\,\overline{Q}\,\overline{R}\,\overline{S} + P\overline{Q}\,\overline{R}\,\overline{S} + P\overline{Q}\,\overline{R}S + P\overline{Q}RS + P\overline{Q}R\overline{S} + \overline{P}\,\overline{Q}R\overline{S}$$

(a) $Y = P\overline{Q} + \overline{Q}\,\overline{S}$ (b) $Y = P\overline{Q} + \overline{Q}R\overline{S}$

(c) $Y = PQ + \overline{Q}\,\overline{R}\,\overline{S}$ (d) $Y = \overline{Q}\,\overline{S} + P\overline{Q}R$

12. Min-term (Sum of Products) expression for a Boolean function is given as follows

$$f(A, B, C) = \sum m(0,1,2,3,5,6)$$

(a) $A + (B \oplus C)$

(b) $A \oplus (B + C)$

(c) $\bar{A} + (B \oplus C)$

(d) $\overline{ABC}$

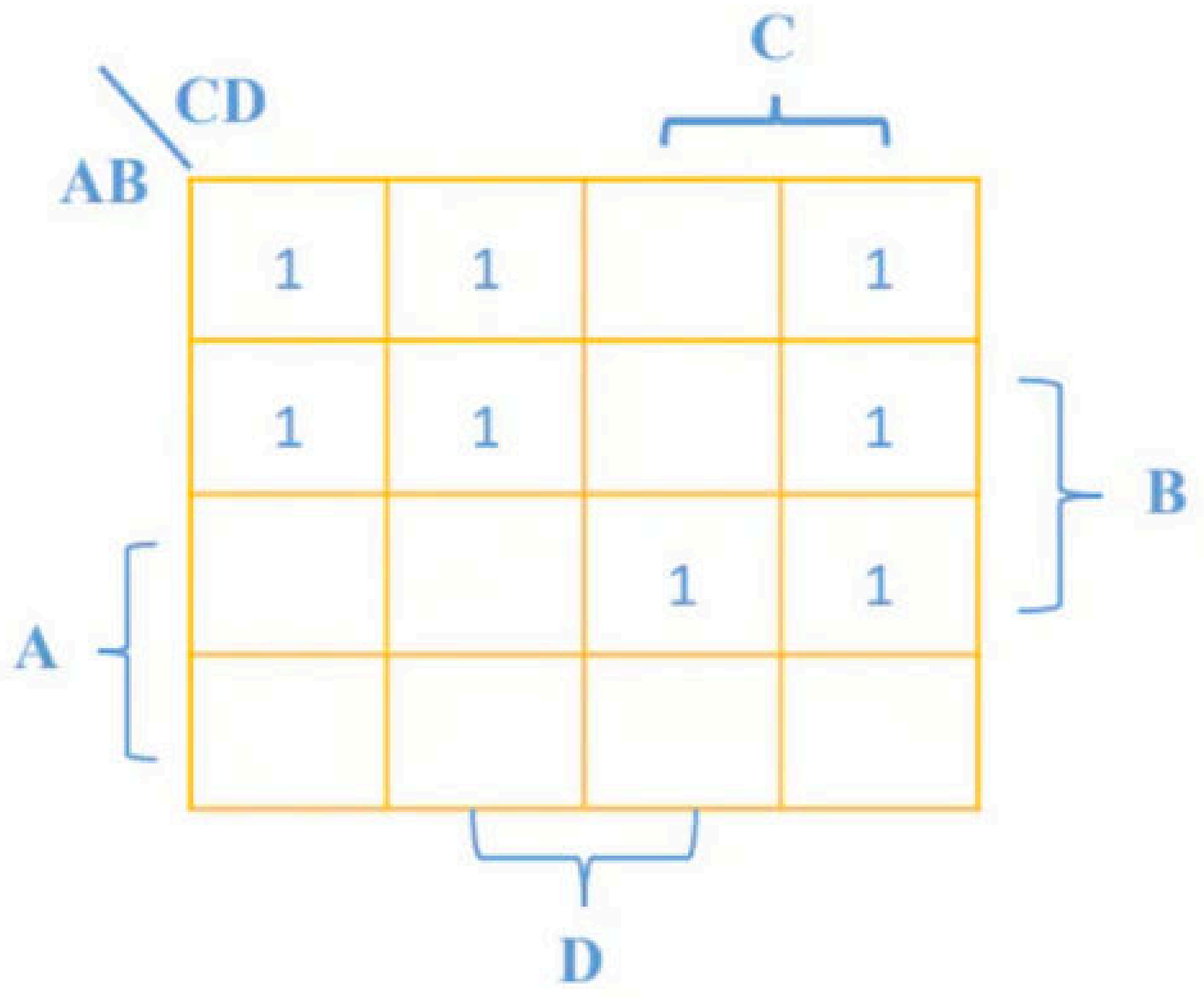
13. The simplified Boolean expression from the Karnaugh map given in the figure below is?

(a) $\overline{A}\,\overline{C} + \overline{A}\,\overline{D} + ABC$

(b) $\overline{A}\,\overline{B} + \overline{A}\,\overline{D} + ABC$

(c) $AC+ACD+ABC+BC\overline{D}$

(d) $\overline{A}\,\overline{B} + \overline{C}\,\overline{D} + \overline{A}\,\overline{D}$



14. How many min terms (excluding redundant terms) does the minimal switching function

$f(v, w, x, y, z) = x + \bar{y}z$ originally have

(a) 16 (b) 20

(c) 24 (d) 32

15. For the Karnaugh map shown in the figure below, the minimal Boolean function is

(a)x^1+z^1+y (b) xz^1+z+yz^1

(c)$xy+z+y^1z$ (d) x^1z^1+yz

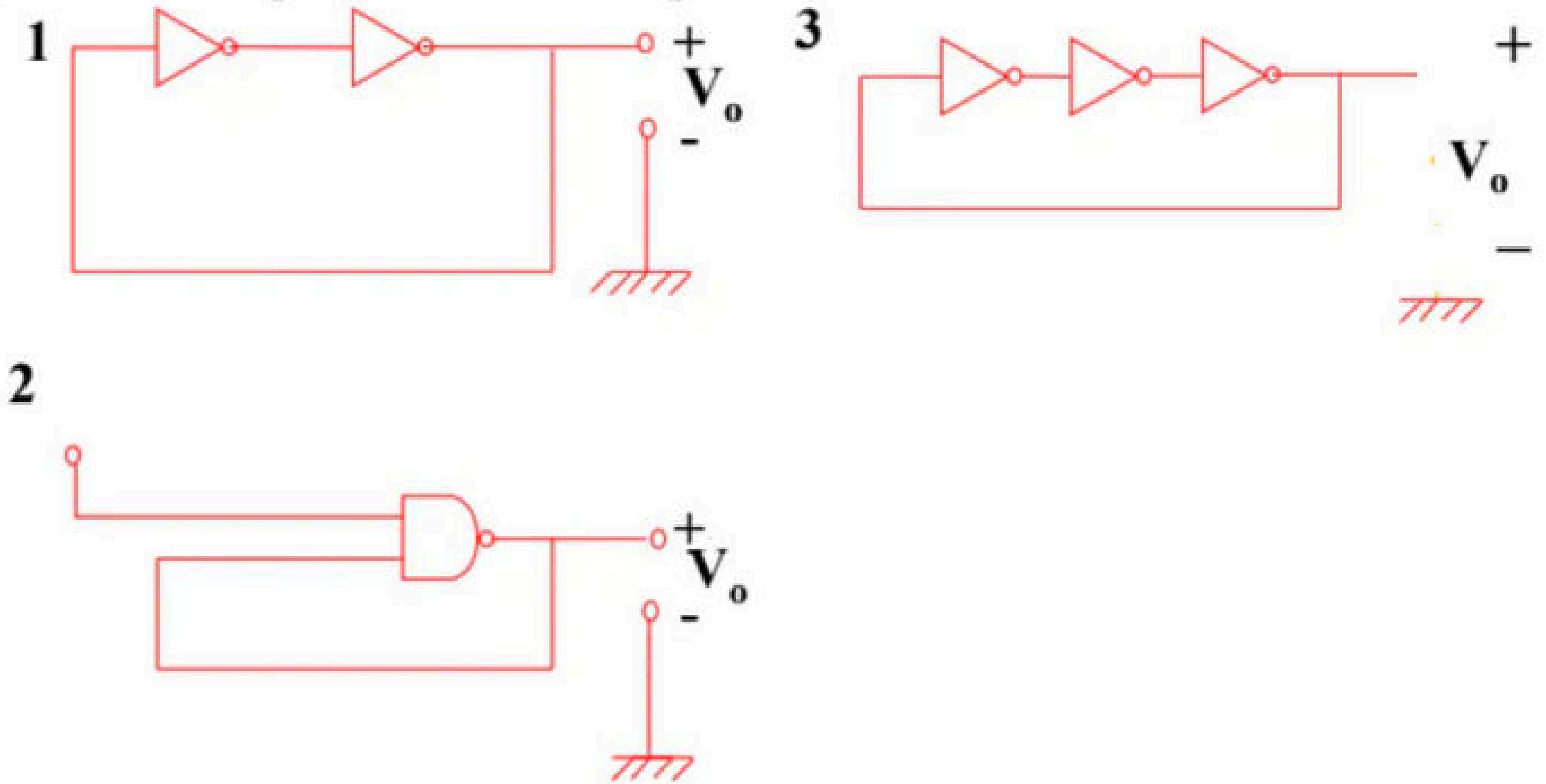
YZ \ X	0	1
00	1	1
01	1	
11	1	1
10	1	1

16. Consider the following circuits (Assume all gates to have a finite propagation delay).

Which of these circuits generate a periodic square wave output?

(a) 1 and 2 (b) 3

(c) 2, 3 (d) 1, 2, 3



17. For a function F, the Karnaugh map is shown in the figure below. Then minimal representation of F is

A \ BC	$\overline{B}\,\overline{C}$	$\overline{B}C$	BC	$B\overline{C}$
$\overline{A}$		1	1	1
A		1	1	

(a) $AB+\overline{C}$ (b) $C+\overline{A}B$

(c) $A+B+C$ (d) $A+\overline{B}C$

A

18. For a four variable K-Map, if each cell is assigned one integer value in range 0-15 then which is the cells adjacent cells adjacent to the cell corresponding to decimal value 7?

(a) 3, 5, 6 and 18 (b) 3, 5, 10 and 11

(c) 3, 5, 6 and 15 (d) 4, 6, 8 and 15

19. While obtaining minimal sum of products expression:

(a) all don't-cares are ignored

(b) all don't-cares are treated as logic ones

(c) all don't-cares are treated as logic zeroes

(d) only such don't-cares that aid minimization are treated as logic ones

20. K-map method of simplification can be applied when the given function is in

(a) Product of sum form

(b) Sum of Product form

(c) Canonical form

(d) Any form

21. Let f (x, y, z) = $\overline{x} + \overline{y}x + xz$ be a switching function. Which one of the following is valid?

(A) $\overline{y}x$ is a prime implicant of f

(B) xz is a min-term of f

(C) xz is an implicant of f

(D) y is a prime implicant of f

22. The function represented by the Karnaugh map given below is:

(A) A.B

(B) AB+ BC+CD

(C) $\overline{B \oplus C}$

(D) A.BC

A \ BC	00	01	10	11
	1	0	0	1
	1	0	0	1

23. Which of the following function implements the Karnaugh map shown below?

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

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

AB \ CD	00	01	11	10
00	0	0	1	0
01	X	X	1	X
11	0	1	1	0
10	0	1	1	0

24. Which functions does NOT implement the Karnaugh map given below?

(A) (w + x) y

(B) xy + yw

(C) $(w + x)(\overline{w} + y)(\overline{x} + y)$

(D) None of the above

xy \ wz	00	01	11	10
00	0	X	0	0
01	0	X	1	1
11	1	1	1	1
10	0	X	0	0

25. Given the following Karnaugh map, which one of the following represents the minimal Sum of Products of the map?

(A) xy + y'z (B) wx'y' + xy + xz

(C) w'x + y'z + xy (D) xz +x'y

yz \ wx	00	01	11	10
00	0	X	0	X
01	X	1	X	1
11	0	X	1	0
10	0	1	X	0

26. Minimum sum of product expression for f(w,x,y,z) shown in Karnaugh-map below is

(A) xz + y'z

(B) xz'+ zx'

(C) x'y + zx'

(D) None of the above

yz \ wx	00	01	11	10
00	0	1	1	0
01	x	0	0	1
11	x	0	0	1
10	0	1	1	x

27. The literal count of a Boolean expression is the sum of the number of times each literal appears in the expression. For example, the literal count of $(xy + xz)$ is 4. What are the minimum possible literal counts of the product of sum and sum of product representations respectively of the function given by the following Karnaugh map? Here, X denotes "don't care".

xy \ wz	00	01	11	10
00	0	X	0	0
01	0	X	1	1
11	1	1	1	1
10	0	x	0	0

(A) (1, 2) (B) (5, 3)

(C) (4, 3) (D) (5, 1)

28. Which are the essential prime implicants of the following Boolean function?

$$f(a, b, c) = a'c + ac' + b'c$$

(A) a'c and ac'

(B) a'c and b'c

(C) a'c only

(D) ac' and bc'

29. Let $f(w, x, y, z) = \Sigma(0,4,5,7,8,9,13,15)$

Which of the following expressions are NOT equivalent to f ?

P. $x'y'z' + w'xy' + wy'z + xz$

Q. $w'y'z' + wx'y' + xz$

R. $w'y'z' + wx'y' + xyz + xy'z$

S. $x'y'z' + wx'y' + w'y$

(A) P only

(B) Q and S

(C) R and S

(D) S only

30. In the Karnaugh map shown above, X denotes a don't care term. What is the minimal form of the function represented by the Karnaugh map?

(A) $\overline{b}.\overline{d} + \overline{a}.\overline{d}$

(B) $\overline{a}.\overline{b} + \overline{b}.\overline{d} + \overline{a}.b.\overline{d}$

(C) $\overline{b}.\overline{d} + \overline{a}.b.\overline{d}$

(D) $\overline{a}.\overline{b} + \overline{b}.\overline{d} + \overline{a}.\overline{d}$

cd \ ab	00	01	11	10
00	1	1		1
01	X			
11	X			
10	1	1		X

31. What is the minimal form of the Karnaugh map shown below? Assume that X denotes a don't care.

(A) $\overline{b}.\overline{d} + \overline{b}.\overline{c}$

(B) $\overline{a}.\overline{b} + \overline{b}.\overline{d} + \overline{a}.b.\overline{d}$

(C) $\overline{b}.\overline{d} + \overline{a}.b.\overline{d}$

(D) $\overline{a}.\overline{b} + \overline{b}.\overline{d} + \overline{a}.\overline{d}$

cd \ ab	00	01	11	10
00	1	X	X	1
01	X			1
11				
10	1			X

32. Consider the following minterm expression for F.

$$F(P, Q, R, S) = \sum 0,5,7,10,15$$

The minterms 2, 7, 8 and 13 are 'do not care' terms. The minimal sum of-products form for F is

(A) $Q\bar{S} + \bar{Q}S$

(B) $\bar{Q}\bar{S} + QS$

(C) $\bar{Q}\bar{R}\bar{S} + \bar{Q}R\bar{S} + Q\bar{R}S + QRS$

(D) $\bar{P}\bar{Q}\bar{S} + \bar{P}QS + PQS + P\bar{Q}\bar{S}$

33. The total number of prime implicates of the function

$$f(w, x, y, z) = \sum(0,2,4,5,6,10) \text{ is } \_\_\_\_$$

34. Consider the Karnaugh map given below, where x represents "don't care" and blank represents 0. Assume for all inputs (a, b, c, d) the respective complements $(\bar{a}, \bar{b}, \bar{c}, \bar{d})$ are also available. The above logic is implemented in 2-input NOR gates only. The minimum number of gates required is ____________.

dc \ ba	00	01	11	10
00		x	x	
01	1			x
11	1			1
10		x	x	

35. Given $f(w, x, y, z) = \Sigma\, m(0,1,2,3,7,8,10) + \Sigma_d(5,6,11,15)$ where d represents the don't care condition in Karnaugh maps. Which of the following is a minimal product-of-sums (POS) form of $f(w, x, y, z)$?

(A) $f = (\overline{w} + \overline{z})(\overline{x} + z)$

(B) $f = (\overline{w} + z)(x + z)$

(C) $f = (w + z)(\overline{x} + z)$

(D) $f = (w + \overline{z})(\overline{x} + z)$

36. If w, x, y, z are Boolean variables, then which one of the following is INCORRECT?

(A) $wx + w(x + y) + x(x + y) = x + wy$

(B) $\overline{w\bar{x}(y + \bar{z})} + \bar{w}x = \bar{w} + x + \bar{y}z$

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

(D) $(w + y)(wxy + wyz) = wxy + wyz$

37. Consider the minterm list form of a Boolean function F given below.

$$f\ (w, x, y, z) = \Sigma m(\ 0,2,5,7,9,11) +\ \Sigma d(3,8,10,12,14)$$

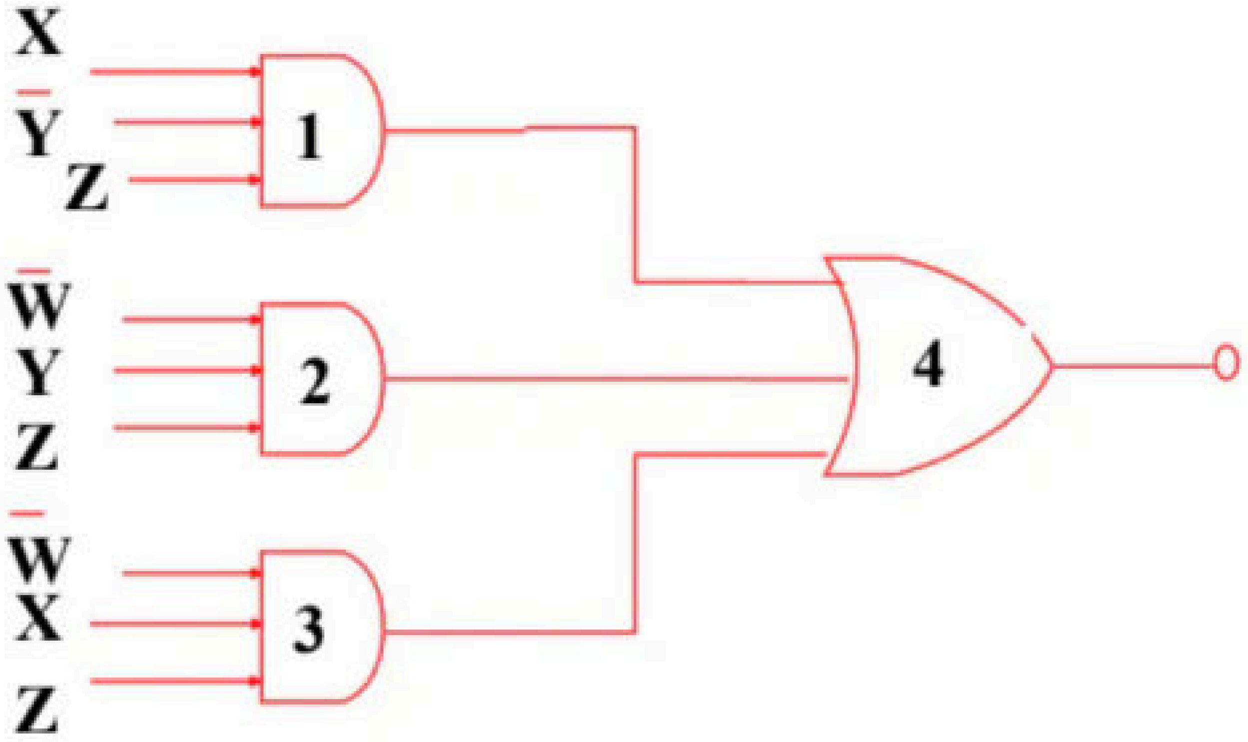
Here, m denotes a minterm and d denotes a don't care term. The number of essential prime implicants of the function F is _______

38. What is the minimum number of 2-input NOR gates required to implement a 4-variable function expressed in sum-of -minterms form as $f = \Sigma(0,1,5,7,8,10,13,15)$ Assume that all the inputs and their complements are available.

39. Which one of the following gates labeled 1, 2, 3, and 4 in the network shown in the figure is redundant?

(a) 1 (b) 2

(c) 3 (d) 4



40. Consider the Boolean function,

$F(w, x, y, z) = wy + xy + \bar{w}xyz + \overline{w}\overline{x}y + xz + \overline{x}\overline{y}\overline{z}.$

Which one of the following is the complete set of essential prime implicants?

(a) $w, y, xz, \overline{x}\overline{z}$

(b) w, y, xz

(c) $y, \overline{x}\overline{y}\overline{z}$

(d) $y, xz, \overline{x}\overline{z}$

41. For an n-variable Boolean function, the maximum number of prime implicants is

(a) $2(n-1)$

(b) $\frac{n}{2}$

(c) 2^{n}

(d) $2^{(n-1)}$

42. In the sum of product function $f(X, Y, Z) = \sum(2,3,4,5)$ the prime implicants are

(a) $\bar{X}Y, X\bar{Y}$ (b) $\bar{X}Y, X\overline{YZ}, X\bar{Y}Z$

(c) $\bar{X}Y\bar{Z}, \bar{X}YZ, X\bar{Y}$ (d) $\bar{X}Y\bar{Z}, \bar{X}YZ, X\overline{YZ}, X\bar{Y}Z$

43. The Minimized expression for the given K-map is (X: don't care)

(a) CB+BD+CD

(b) $AB+C\overline{B}+B\overline{C}$

(c) $C\overline{B}+AC+B\overline{C}$

(d) $\overline{C}B+BD+C\overline{B}$

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

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

(a) 2 (b) 3

(c) 4 (d) 5

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

45. Consider the Karnaugh map given below:

The function represented by this map can be simplified to the minimal form as

(a) $X_1 \overline{X}_2 \overline{X}_4 + X_2 X_4 + X_1 \overline{X}_3$

(b) $X_1 X_2 X_4 + X_2 X_4 + X_1 \overline{X}_2 \overline{X}_3 \overline{X}_4$

(c) $X_2 X_4 + \overline{X}_2 \overline{X}_4 + X_3 \overline{X}_1$

(d) $X_1 \overline{X}_2 \overline{X}_4 + \overline{X}_1 X_2 \overline{X}_3 X_4 + X_1 X_2$

X_1X_2 \ X_3X_4	00	01	11	10
00	1		d	D
01		1	d	1
11		d	1	
10	1	d		D

46. The Minimized expression for the given K-map (x: don’t-care) is.

(a) $A+\overline{B}C$ (b) $B+AC$

(c) $C+AB$ (d) ABC

CD \ AB	00	01	11	10
00	0	0	1	1
01	0	X	X	1
11	X	X	1	X
10	1	0	1	1

47. By inspecting the Karnaugh map plot of the switching function $F(X_1 X_2 X_3) = \sum (1,3,6,7)$ can say that the redundant prime implicant is

(a) $\overline{X}_1 X_3$ (b) $X_2 X_3$

(c) $X_1 X_2$ (d) X_3

48. What is the minimized logic expression corresponding to the given Karnaugh-map?

(a) XZ

(b) $\overline{W}\,X\,\overline{Y} + \overline{W}\,Y\,Z + W\,\overline{Y}\,Z + W\,X\,Y$

(c) $\overline{W}\,X\,\overline{Y} + \overline{W}\,Y\,Z + W\,\overline{Y}\,\overline{Z} + W\,X\,\overline{Y}$

(d) $XZ + \overline{W}\,Y\,Z + \overline{W}\,X\,\overline{Y} + W\,X\,Y + W\,\overline{Y}\,Z$

WX \ YZ	00	01	11	10
00			1	
01	1	1	1	
11		1	1	1
10		1		

49. When the Boolean function $F(X_1\ X_2\ X_3) = \sum(0,1,2,3) + \sum\emptyset\ (4,5,6,7)$ is minimised, what does one get?

(a) 1 (b) 0

(c) X_1 (d) X_3

50. Consider the following statements:

1.Minimization using Karnaugh map may not provide unique solution.

2.Redundant grouping in Karnaugh map may result in non-Minimized solution.

3.Don't care states if used in Karnaugh map for Minimization, the minimal solution is not obtained.

Which of the statements given above are correct?

(a) 1, 2 and 3 (b) 2 and 3 only

(c) 1 and 3 only (d) 1 and 2 only

51. Digital input signals A, B, C with A as the MSB and C as the LSB are used to realize the Boolean function $F = m_0 + m_2 + m_3 + m_5 + m_7$, where m_i denotes the i th minterm. In addition, F has a don't care for m_1. The simplified expression for F is given by

(a) $\overline{A}\overline{C} + \overline{B}C + AC$ (b) $\overline{A} + C$

(c) $\overline{C} + A$ (d) $\overline{A}C + BC + A\overline{C}$