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Indian Institute of Technology
Hyderabad

GATE Exercises on Boolean Logic

Teaching Learning Center
IIT Hyderabad

Abstract—**This problem set has questions related to Boolean logic and gates taken from GATE papers over the last twenty years. Teachers can use the problem set for courses tutorials.**

1) 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
2) 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 minimised expression of the function is
   a) $(\overline{B}+C)(\overline{A}+C)(\overline{A}+\overline{B})(\overline{C}+D)$
   b) $(\overline{B}+C)(\overline{A}+C)(\overline{A}+\overline{C})(\overline{C}+D)$
   c) $(\overline{B}+C)(\overline{A}+C)(\overline{A}+\overline{C})(\overline{C}+\overline{D})$
   d) $(\overline{B}+C)(A+\overline{B})(\overline{A}+\overline{B})(\overline{C}+D)$
3) The Boolean expression$F(X,Y,Z) = \overline{X}Y\overline{Z} + X\overline{Y}.\overline{Z} + XY\overline{Z} + XYZ$ converted into the canonical product of sum (POS) form is
   a) $(X+Y+Z)(X+Y+\overline{Z})(X+Y+\overline{Z})(X+\overline{Y}+\overline{Z})(\overline{X}+Y+\overline{Z})$
   b) $(X+\overline{Y}+Z)(\overline{X}+Y+Z)(\overline{X}+\overline{Y}+Z)(\overline{X}+\overline{Y}+\overline{Z})$
   c) $(X+Y+Z)(\overline{X}+Y+\overline{Z})(X+\overline{Y}+Z)$
   d) $(X+\overline{Y}+\overline{Y})(\overline{X}+Y+Z)(X+Y+Z)$
4) If the functions W, X, Y and Z are as follows $W = R + \overline{P}Q + \overline{R}S$ $X = PQ\overline{R}.\overline{S} + \overline{P}.\overline{Q}.\overline{R}.\overline{S} + P\overline{Q}.\overline{R}.\overline{S}$ $Y = \overline{RS + PR + P\overline{Q} + \overline{P}.\overline{Q}}$ $Z = R + S + \overline{PQ + \overline{P}.\overline{Q}.\overline{R} + P\overline{Q}.\overline{S}}$
   a) $W = Z, X = \overline{Z}$
   b) W = Z, X = Y
   c) W=Y
   d) W = $Y = \overline{Z}$
5) The Boolean expression $AC+B\overline{C}$ is equivalent to
   a) $AC + \overline{BC}$
   b) $\overline{B}C + AC + B\overline{C} + \overline{A}C\overline{B}$
   c) $AC + B\overline{C} + \overline{B}C + ABC$
   d) $ABC + A\overline{B}.C + AB\overline{C} + \overline{A}.B.\overline{C}$
6) The boolean expression $Y = \overline{A}.\overline{B}.\overline{C}D + \overline{A}BC\overline{D} + A\overline{B}.\overline{C}D + AB\overline{C}.\overline{D}$ can be
   a) $Y = \overline{A}.\overline{B}.\overline{C}D + \overline{A}B\overline{C} + A\overline{C}D$
   b) $Y = \overline{A}.\overline{B}.\overline{C}D + BC\overline{D} + A\overline{B}.\overline{C}D$
   c) $Y = \overline{A}BC\overline{D} + \overline{B}.\overline{C}D + A\overline{B}.\overline{C}D$
   d) $Y = \overline{A}BC\overline{D} + \overline{B}.\overline{C}D + AB\overline{C}.\overline{D}$
7) The Boolean expression$\overline{X}Y\overline{Z} + \overline{X}.\overline{Y}Z + XY\overline{Z} + X\overline{Y}Z + XYZ$ cab be simplified to
   a) $X\overline{Z} + \overline{X}Z + YZ$
   b) $XZ + \overline{Y}Z + Y\overline{Z}$
   c) $\overline{X}Y + YZ + XZ$
   d) $\overline{XY} + Y\overline{Z} + \overline{X}Z$
8) The simplified form of the Boolean expression $Y = (\overline{A}BC + D)(\overline{A}D + \overline{B}.\overline{C})$ can be written as
   a) $\overline{A}D + \overline{B}.\overline{C}D$
   b) $AD + B\overline{C}D$
   c) $(\overline{A}+D)(\overline{B}C+\overline{D})$
   d) $A\overline{D} + BC\overline{D}$
9) 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) $(\overline{X}+\overline{Y}+\overline{Z})(\overline{X}+Y+Z)(X+\overline{Y}+\overline{Z})$

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

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

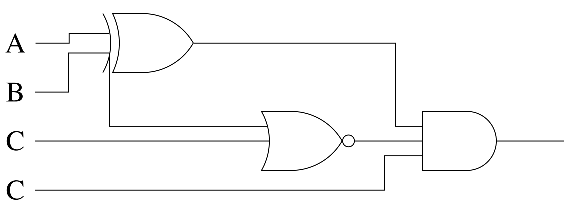

Fig. 10

a) $1,0,1$
b) $0,0,1$
c) $1,1,1$
d) $0,1,1$

11) For the logic circuit shown in Fig., the simplified Boolean expression for the output Y is

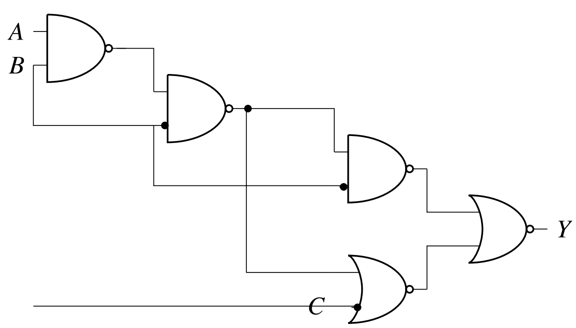

Fig. 11

a) A+B+C
b) 0
c) 1
d) C

12) If X=1 in logic equation $[X+Z\overline{Y}+(\overline{Z}+X\overline{Y})]\overline{X}+\overline{Z}(X+Y)=1$, then

a) Y=Z
b) $Y=\overline{Z}$
c) $Z=1$
d) $Z=0$

13) The output Y in the circuit below is always '1' when

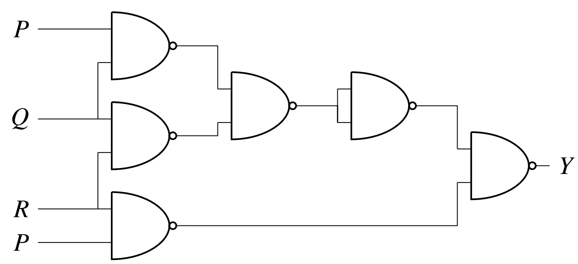

Fig. 13

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'

14) In the sum of product function f(X,Y,Z)=$\sum(2,3,4,5)$,prime implicants are

a) $\overline{X}Y, X\overline{Y}$
b) $\overline{X}Y, X\overline{Y}.\overline{Z}, X\overline{Y}Z$
c) $\overline{X}Y\overline{Z}, \overline{X}YZ, X\overline{Y}$
d) $\overline{X}Y\overline{Z}, \overline{X}YZ, X\overline{Y}.\overline{Z}, X\overline{Y}Z$

15) The logic function f=$\overline{(X.\overline{Y})+(\overline{X}.Y)}$ is same as

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

16) The minimal product of sums function described by the K-map given in Fig.

a) $\overline{A}.\overline{C}$
b) $\overline{A}+\overline{C}$
c) $A+C$
d) AC

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

C \ AB	00	01	11	10
0	1	1	x	0
1	0	0	x	0

Fig. 16

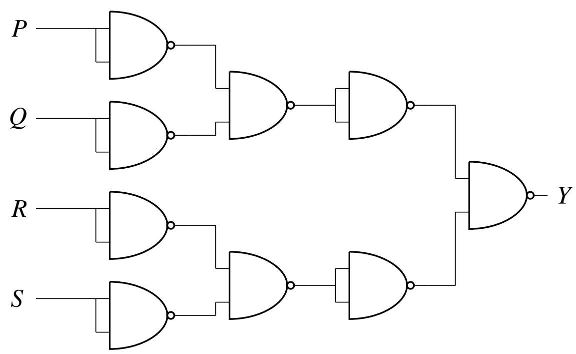

Fig. 17

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

18) The following Karnaugh map represents a function F(X,Y,Z),minimized form of the function F is

X \ YZ	00	01	11	10
0	1	1	1	0
1	0	0	1	0

Fig. 18

a) $\overline{X}Y+YZ$
b) $\overline{X}.\overline{Y}+YZ$
c) $\overline{XY}+Y\overline{Z}$
d) $\overline{XY}+\overline{Y}Z$

19) The output Y of the logic circuit given below is

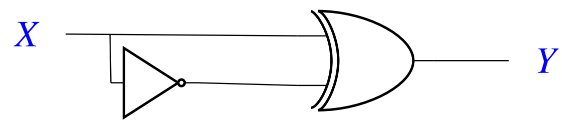

Fig. 19

a) 1
b) 0
c) X
d) $\overline{X}$

20) The Boolean expression $AB+A\overline{C}+BC$ simplifies to
a) $BC+A\overline{C}$
b) $AB+A\overline{C}+B$
c) $AB+A\overline{C}$
d) $AB+BC$

21) The output expression for the Karnaugh map shown below is

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

Fig. 21

a) $B\overline{D}+BCD$
b) $B\overline{D}+AB$
c) $\overline{B}D+ABC$
d) $B\overline{D}+ABC$

22) For 3 input logic circuit shown below,the output Z can be expressed as

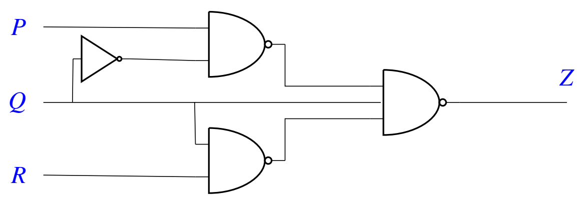

Fig. 22

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

23) Given $f(W, X, Y, Z) = \sum m(0, 1, 2, 3, 7, 8, 10) + \sum d(5, 6, 11, 15)$, where d represent don't-care condition in Karnaugh maps.Which of the following is a minimum product-of-sum(POS)form of f(X,Y,Z,W)?

a) $(\overline{W} + \overline{Z})(\overline{X} + Z)$
b) $(\overline{W} + Z)(X + Z)$
c) $(W + Z)(\overline{X} + Z)$
d) $(W + \overline{Z})(\overline{X} + Z)$

24) The output expression for the Karnaugh map shown below is

A \ BC	00	01	11	10
0	1	0	0	1
1	1	1	1	1

Fig. 24

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

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

a) 1
b) $\overline{ab}$
c) ab
d) 0

26) $f(A, B, C, D) = \Pi M(0, 1, 3, 4, 5, 7, 9, 11, 12, 13, 14, 15)$ 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) $(A + \overline{C} + D)(\overline{A} + B + D)$
b) $A\overline{C}D + \overline{A}BD$
c) $\overline{A}C\overline{D} + A\overline{B}C\overline{D}$
d) $(B+\overline{C}+D)(A+\overline{B}+\overline{C}+D)(\overline{A}+B+C+D)$

27) Consider the following Sum of Products expression, F.

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

The equivalent Product of Sums expression is

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

28) The number of product term in the minimized sum-of-product expression obtained through the following K-map is(where "d"denote don't-care states)

a) 2
b) 3
c) 4
d) 5

29) The minimum 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) $P\overline{Q} + \overline{Q}.\overline{S}$

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

Fig. 28

b) $P\overline{Q} + \overline{Q}R\overline{S}$
c) $P\overline{Q} + \overline{Q}.\overline{R}.\overline{S}$
d) $\overline{Q}.\overline{S} + P\overline{Q}R$

30) A logic circuit implements the Boolean function $F = \overline{X}Y + X\overline{Y}.\overline{Z}$. It is found that the input combination $X = Y = 1$ can never occur. Taking this into account, a simplified expression for F,
a) $\overline{X} + \overline{Y}.\overline{Z}$
b) $X + Z$
c) $X + Y$
d) $Y + X\overline{Z}$

31) The logic evaluated by the circuit at the output is

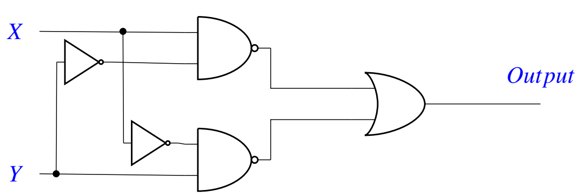

Fig. 31

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

32) The Boolean expression $XY + (\overline{X} + \overline{Y})Z$ is equivalent to
a) $XY\overline{Z} + \overline{X}.\overline{Y}Z$
b) $\overline{X}.\overline{Y}.\overline{Z} + XYZ$
c) $(X + Z)(Y + Z)$
d) $(\overline{X} + Z)(\overline{Y} + Z)$

33) In the digital circuit given below, F is

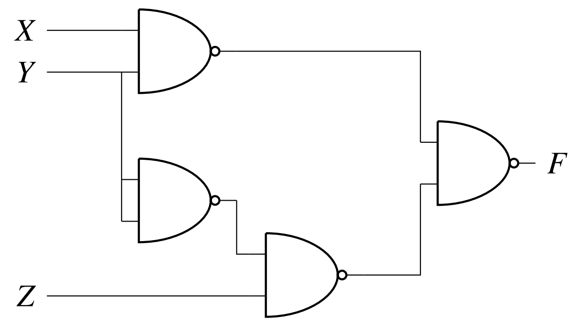

Fig. 33

a) $XY + Y\overline{Z}$
b) $XY + \overline{Y}Z$
c) $\overline{X}.\overline{Y}$
d) $XZ + \overline{Y}$

34) For the Boolean expression $f = \overline{a}.\overline{b}.\overline{c} + \overline{a}b\overline{c} + a\overline{b}.\overline{c} + abc + ab\overline{c}$,the minimized Product of Sum (PoS) expression is
a) $f = (b + \overline{c})(a + \overline{c})$
b) $f = (\overline{b} + c)(\overline{a} + c)$
c) $f = (\overline{b} + c)(a + \overline{c})$
d) $f = \overline{c} + abc$

35) The minimal sum-of-products expression for the logic function f represented by the given Karnaugh map is
a) $QS + P\overline{R}S + PQR + \overline{P}RS + \overline{P}Q\overline{R}$
b) $\overline{QS} + \overline{P}R\overline{S} + \overline{P}.\overline{Q}R + P\overline{R}.\overline{S} + P\overline{Q}\,\overline{R}$
c) $\overline{P}R\overline{S} + \overline{P}.\overline{Q}.\overline{R}$
d) $P\overline{R}S + PQR + \overline{P}RS + \overline{P}Q\overline{R}$

36) The expression $A + \overline{A}B$ is equivalent to
a) $A + B$
b) $A + \overline{B}$
c) $AB + A$
d) AB

37) The simplest form of the Boolean expression $AB\overline{C}.\overline{D} + ABC\overline{D} + AB\overline{C}D + ABCD$

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

Fig. 35

a) AD
b) BC
c) $\overline{A}B$
d) AB

38) The Karnaugh map for a four variable Boolean function is given in Fig.

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

Fig. 38

a) $PQRS + \overline{Q}S$
b) $\overline{P}QR\overline{S} + \overline{Q}S$
c) $PQR + Q\overline{S}$
d) $PQRS + \overline{Q}$

39) The simultaneous equations on the Boolean variables x, y, z and w,

$$x + y + z = 1$$

$$xy = 0$$

$$xz + w = 1$$

$$xy + \overline{z}.\overline{w} = 0$$

have following solution for x,y,z and w,respectively:

a) 0100
b) 1101
c) 1011
d) 1000

40) If P, Q, R are Boolean variables, then

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

Simplifies to

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

41) 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

Fig. 41

42) Given the following Karnaugh map, which one of the following represents the minimal Sum-Of-Products of the map?

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

Fig. 42

a) $XY+\overline{Y}Z$
b) $W\overline{X}.\overline{Y}+XY+XZ$
c) $\overline{W}X+\overline{Y}Z+XY$
d) $XZ+Y$

43) Minimum sum of product expression for f(w,x,y,z) shown in Karnaugh-map below is

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

Fig. 43

a) $XZ+\overline{Y}Z$
b) $X\overline{Z}+Z\overline{X}$
c) $\overline{X}Y+Z\overline{X}$
d) None of the above

44) The minterm expansion of $f(P,Q,R)=PQ+Q\overline{R}+P\overline{R}$

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) $m_2+m_3+m_4+m_5$

45) In the Karnaugh map shown below, X denotes a don't care term. What is the minimal form of the function represented by the Karnaugh map?

cd \ ab	00	01	11	10
00	1	1		1
01	x			
11	x			
10	1	1		x

Fig. 45

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) $\overline{a}.\overline{b}+\overline{b}.\overline{d}+\overline{a}.\overline{d}$

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

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

is

a) $\overline{P}Q+\overline{R}$
b) $P+\overline{Q.R}$
c) $\overline{P}Q+R$
d) $PQ+R$

47) 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 input A, B and C, with A as MSB and C as the LSB.

a) $\bar{A}B + \bar{A}\bar{B}\bar{C} + A\bar{B}C$
b) $\bar{A}\bar{C} + \bar{A}B + A\bar{B}C$
c) $\bar{A}\bar{C} + A\bar{B} + A\bar{B}C$
d) $\bar{A}BC + \bar{A}\bar{C} + A\bar{B}C$

48) What is the minimal form of the Karnaugh map shown below? Assume that X denotes a don't care term.

a) $\overline{b}.\overline{d}$
b) $\overline{b}.\overline{d} + \overline{b}.\overline{c}$
c) $\overline{b}.\overline{d} + a\overline{b}.\overline{c}d$
d) $\overline{b}.\overline{d} + \overline{b}.\overline{c} + \overline{c}.\overline{d}$

cd \ ab	00	01	11	10
00	1	x	x	1
01	x			1
11				
10	1			x

Fig. 48

49) Consider the Boolean function, $F(W, X, Y, Z) = WY + XY + \bar{W}XYZ + \bar{W}\bar{X}Y + XZ + \bar{X}\bar{Y}\bar{Z}$. Which of the following is the complete set of essential prime implicants ?

a) $W, Y, XZ, \bar{X}\bar{Z}$
b) W, Y, XZ
c) $Y, \bar{X}\bar{Y}\bar{Z}$
d) $Y, XZ, \bar{X}\bar{Z}$

50) The truth table represents the Boolean function

X	Y	f(X,Y)
0	0	0
0	1	0
1	0	1
1	1	1

a) X
b) $X + Y$
c) $X \oplus Y$
d) Y

51) The function $F(A, B, C)$ defined by three Boolean variables A, B and C when expressed as sum of products is given by

$$F = \bar{A}\bar{B}\bar{C} + \bar{A}B\bar{C} + A\bar{B}\bar{C} \tag{0.0.1}$$

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

52) A traffic signal cycles from GREEN to YELLOW, YELLOW to RED and RED to GREEN. In each cycle, GREEN is turned on for 70 seconds, YELLOW is turned on for 5 seconds and RED is turned on for 75 seconds. This traffic light has to be implemented using a finite state machine (FSM). The only input to this FSM is a clock of 5 second period. The minimum number of flip-flops required to implement this FSM is ....

53) In Fig. 53, the number of distinct values of $X_3X_2X_1X_0$ (out of the 16 possible values) that give $Y = 1$ is ....

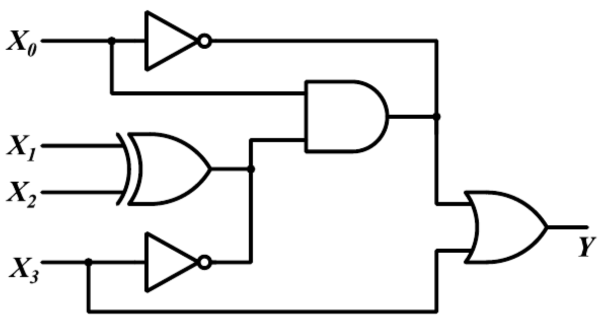

Fig. 53