Q.21 The 2's complement representation of $(-539)_{10}$ in hexadecimal is **[GATE : 2001]**

(A) ABE (B) DBC 110111100101 (C) DE5 (D) 9E7

Q.22 Let $A = 1111\ 1010$ and $B = 0000\ 1010$ be two 8-bit 2's complement numbers. Their product in 2's complement is **[GATE : 2004]**

-6 10

(A) 1100 0100 (B) 1001 1100 (C) 1010 0101 (D) 1101 0101

-60

Q.23 Consider the equation $(43)_x = (y3)_8$ where x and y are unknown. The number of possible solutions is

5 Ans $x>4$ $y<8$ $\boxed{x = 2y}$ 5 6 8 | 5/2 3 4 | 10 12 14 | 5 6 7

[GATE : 2015]

Q.24 In 16-bit 2's complement representation, the decimal number −28 is: **[GATE : 2019]**

(A) 1111 1111 0001 1100
(B) 0000 0000 1110 0100
(C) 1111 1111 1110 0100
(D) 1000 0000 1110 0100

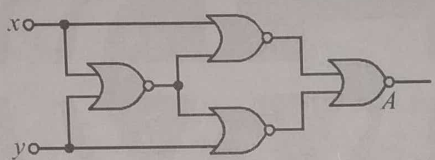
Q.25 Consider Z = X − Y where X, Y and Z are all in sign-magnitude form. X and Y are each represented in n bits. To avoid overflow, the representation of Z would require a minimum of: **[GATE : 2019]**

(A) n bits
(B) n−1 bits
(C) n+1 bits
(D) n+2 bits

$Z = 6 - (-5) \rightarrow$ (3 bit magnitude + 1 bit sign)
$= 11 \rightarrow (4+1)$ bit

Chapter - 2 : Number Systems

Q.26 Identify the logic function performed by the circuit shown in figure **[GATE : 1993]**



(A) Exclusive OR
(B) Exclusive NOR
(C) NAND
(D) NOR

Q.27 Let * be defined as **[GATE : 1997]**

$x * y = \bar{x} + y$, Let z = x*y.

Value z * x is

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

(A) $\bar{x} + y$
(B) x
(C) 0
(D) 1

Q.28 Which of the following operations is commutative but not associative? **[GATE : 1998]**

(A) AND
(B) OR
(C) NAND
(D) EXOR

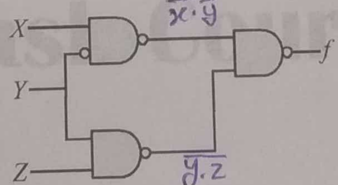
Q.29 Which of the following expression is not equivalent to $\bar{x}$? **[GATE : 1999]**

(A) x NAND x
(B) x NOR x
(C) x NAND 1
(D) x NOR 1

Q.30 The Boolean function $x'y' + xy + x'y$ $+x'y$ is equivalent to $\rightarrow x'(y'+y) + y(x+x')$ **[GATE : 2004]**

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

Q.31 Consider the following circuit. **[GATE : 2005]**



$f = \overline{\overline{x \cdot \bar{y}} \cdot \overline{\bar{y} z}}$
$= x \cdot \bar{y} + \bar{y} z$

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

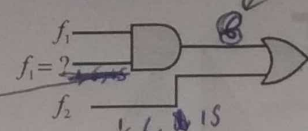
Q.32 Given f_1, f_3 and f in canonical sum of products form (in decimal) for the circuit. **[GATE : 2008]**

$f_1 = \Sigma m\ (4, 5, 6, 7, 8)$

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

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

Then f_2 is



(A) $\Sigma m\ (4, 6)$ (B) $\Sigma m\ (4, 8)$ (C) $\Sigma m\ (6, 8)$ (C) $\Sigma m\ (4, 6, 8)$

Q.33 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? **[GATE : 2009]**

(A) 2 (B) 3 (C) 4 (D) 5

AB+CC form

Q.34 The minterm expansion of **[GATE : 2010]**

$f(P,Q,R) = PQ + Q\overline{R} + P\overline{R}$ 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) $m_2 + m_3 + m_4 + m_5$

Q.35 The simplified SOP (Sum of Product) form of the Boolean expression **[GATE : 2011]**

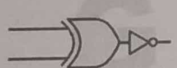
$\left(P+\overline{Q}+\overline{R}\right).\left(P+\overline{Q}+R\right).\left(P+Q+\overline{R}\right)$ is ________

$\pi(3,2,1) = \Sigma(0,4,5,6,7)$

(A) $\left(\overline{P}.Q+\overline{R}\right)$ (B) $\left(P+\overline{Q}.\overline{R}\right)$ (C) $\left(\overline{P}.Q+R\right)$ (D) $\left(P.Q+R\right)$

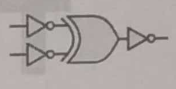
Q.36 Which one of the following circuits is NOT equivalent to a 2-input XNOR (exclusive NOR) gate?

(A)



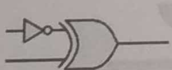
$\Rightarrow \overline{A \oplus B}$

(B)



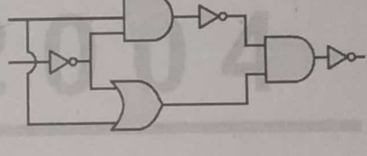
$\overline{\bar{A} \oplus \bar{B}} = \overline{A \oplus B}$

(C)



$\bar{A} \oplus B = \overline{A \oplus B}$

(D)



Q.37 The truth table **[GATE : 2012]**

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

Represents the Boolean function

(A) X (B) X + Y (C) X ⊕ Y (D) Y

Q.38 Which one of the following expressions does NOT represent exclusive NOR of x and y? **[GATE : 2013]**

(A) $xy + x'y'$ (B) $x \oplus y'$ (C) $x' \oplus y$ (D) $x' \oplus y'$

Q.39 The dual of a Boolean function $F(X_1, X_2, ..., X_n, +, \cdot, ')$, written as F^D, is the same expression as that of F with + and $\cdot$ swapped. F is said to be self- dual if $F = F^D$. The number of self – dual function with n Boolean variables is **[GATE : 2014]**

(A) 2^n (B) 2^{n-1} (C) 2^{2^n} (D) $2^{2^{n-1}}$

Q.40 Consider the Boolean operator # with the following properties: **[GATE : 2016]**

$x \# 0 = x,\ x \# 1 = \bar{x},\ x \# x = 0$ and $x \# \bar{x} = 1$.

Then x # y is equivalent to $\longrightarrow x \oplus y$

(A) $x\bar{y} + \bar{x}y$ (B) $x\bar{y} + \bar{x}\bar{y}$ (C) $\bar{x}y + xy$ (D) $xy + \bar{x}\bar{y}$

Q.41 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.

$1 \oplus 1 \oplus 1 \oplus 1 = 0$

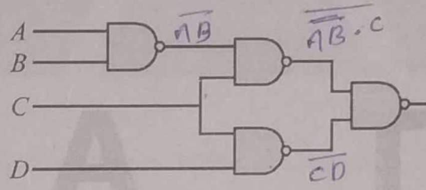
Which one of the following must always be TRUE? **[GATE : 2016]**

(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) $x_1 + x_2 + x_3 + x_4 = 0$

$1 \oplus 1 = 1 \oplus 1 \Rightarrow \boxed{0 = 0}$

Q.42 The logic expression for the output of the circuit shown in figure 1 is **[GATE : 1994]**



$\overline{\overline{\overline{AB}\cdot C}\cdot\overline{CD}} = \overline{AB}\cdot C + CD$

$(\bar{A} + \bar{B})C + CD$

(A) $\bar{A}C + \bar{B}C + CD$ (B) $A\bar{C} + B\bar{C} + \bar{C}D$ (C) $ABC + \overline{CD}$ (D) $\overline{AB} + \overline{BC} + \overline{CD}$

Q.43 What values of A, B, C and D satisfy the following simultaneous Boolean equations? **[GATE : 1995]**

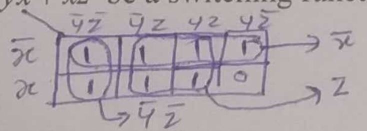
$\bar{A} + AB = 0,\ AB = AC,\ \ AB + A\bar{C} + CD = \bar{C}D$

(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 = 1, B = 0, C = 0, D = 0

Q.44 Let $f(x, y, z) = \bar{x} + \bar{y}x + xz$ be a switching function. Which one of the following is valid?

$xzy + xz\bar{y} + x\bar{y}\bar{z} + \bar{x}\bar{y}\bar{z} + \bar{x}\bar{y}z + \bar{x}y\bar{z} + \bar{x}yz$

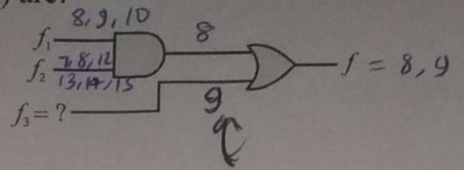


[GATE : 1997]

(A) $\bar{y}x$ is a prime implicant of f (B) xz is a minterm of f

(C) xz is an implicant of f (D) y is a prime applicant of f

Q.45 Consider the logic circuit shown in the below figure. The functions f_1, f_2 and f (in canonical sum of products form in decimal notation) are: **[GATE : 1997]**



$$f_1(w,x,y,z) = \Sigma 8,9,10$$

$$f_2(w,x,y,z) = \Sigma 7,8,12,13,14,15$$

$$f(w,x,y,z) = \Sigma 8,9$$

The function f_3 is

(A) $\Sigma 9,10$ (B) $\Sigma 9$ (C) $\Sigma 1,8,9$ (D) $\Sigma 8,10,15$

Q.46 Which of the following sets of component (s) is/are sufficient to implement any arbitrary Boolean function? **[GATE : 1999]**

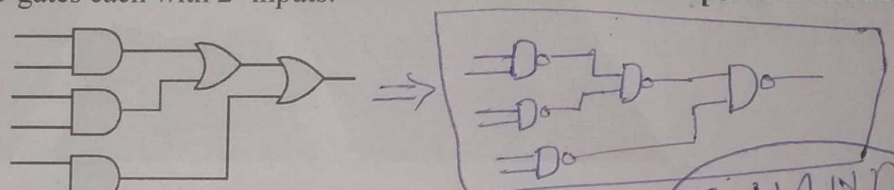
(A) XOR gates, NOT gates

(B) 2 to 1 multiplexors

(C) AND gates, XOR gates → $AB + C \Rightarrow$ $C=0 \rightarrow$ AND, $B=1 \rightarrow$ OR

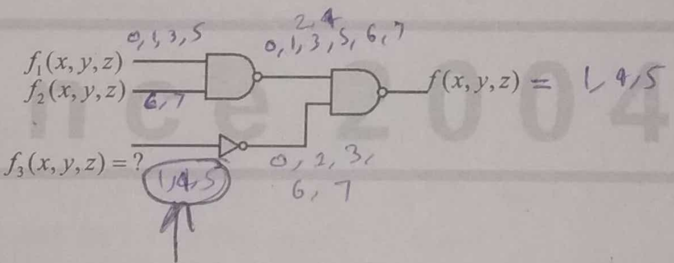
(D) Three – input gates that output (A.B) + C for the inputs A, B and C

Q.47 Transform the following logic circuit (without expressing its switching function) into an equivalent logic circuit that employs only 6 NAND gates each with 2- inputs. **[GATE : 2002]**



5 NAND gates

Q.48 Consider the following logic circuit whose inputs are function f_1, f_2, f_3 and output is f. **[GATE : 2002]**



Given that

$$f_1(x,y,z) = \Sigma(0,1,3,5)$$

$$f_2(x,y,z) = \Sigma(6,7) \text{ and}$$

$$f(x,y,z) = \Sigma(1,4,5), f_3 \text{ is}$$

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

(A) Σ (1, 4, 5) (B) Σ (6, 7) (C) Σ (0, 1, 3, 5) (D) None of the above

Q.49 Let f(A,B) = A' + B Simplified expression for function f (f (x + y, y), z) is **[GATE : 2002]**

(A) (x' + z) (B) x y z (C) xy' + z (D) None of the above

Q.50 Which are the essential prime implicants of the following Boolean function? EPI **[GATE : 2004]**

$f(a, b, c) = a'c + ac' + b'c$

(A) $a'c$ and ac' (B) $a'c$ and $b'c$ (C) $a'c$ only (D) ac' and bc'

Q.51 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 ? **[GATE : 2007]**

(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

Q.52 Define the connective * for the Boolean variables X and Y as: X * Y = XY + X'Y'. Let Z = X * Y. Consider the following expressions P, Q and R. **[GATE : 2007]**

P: X = Y * Z, Q: Y = X * Z,

R: X * Y * Z = 1

$P: X = Y \odot Z = Y \odot (X \odot Y) = X$

$Q: Y = X \odot Z = X \odot (X \odot Y) = Y$

$R: (X \odot Y) \odot (X \odot Y) = 1$

Which of the following is TRUE?

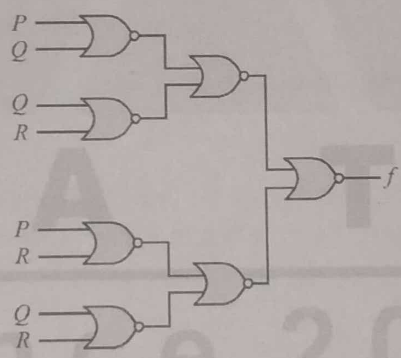
(A) Only P and Q are valid (B) Only Q and R are vaild

(C) Only P and R are valid (D) All P, Q, R are valid

Q.53 If P, Q, R are Boolean variable, then $(P+\overline{Q})(P.\overline{Q}+P.R)(\overline{P}.\overline{R}+\overline{Q})$ simplifies to **[GATE : 2008]**

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

Q.54 What is the Boolean expression for the output f of the combinational logic circuit of NOR gates given below ? **[GATE : 2008]**



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

Q.55 Let ⊕ denote the exclusive OR(XOR) operation. Let '1' and '0' denote the binary constants. Consider the following Boolean expression for F over two variables P and Q: **[GATE : 2014]**

$$F(P,Q) = (1\oplus P)\oplus\underbrace{(P\oplus Q)\oplus(P\oplus Q)}_{0}\oplus(Q\oplus 0) \longrightarrow \bar{P}\oplus Q = \overline{P\oplus Q}$$

The equivalent expression for F is

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

Q.56 The number of min – term after minimizing the following Boolean expression is 1. **[GATE : 2015]**

$$[D' + AB' + A'C + AC'D + A'C'D]' = \boxed{ABCD} \text{ Ans}$$

AB \ CD				
	0	0	0	0
	0	0	0	0
	0	0	1	0
	0	0	0	0

→ ABCD

Q.57 If w, x, y, z, are Boolean variables, then which one of the following is INCORRECT? **[GATE : 2017]**

(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) $\left(w\bar{x}(y+x\bar{z})+\overline{wx}\right)y=x\bar{y}$

$(\bar{x}y) \neq x$

(D) $(w + y)(wxy + wyz) = wxy + wyz$

Q.58 Find the minimum product of sums of the following expression **[GATE : 1990]**

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

$\boxed{(\bar{A}+B)(A+\bar{C})(\bar{B}+C)}$ Ans

Q.59 Find the minimum sum of products form of the logic function **[GATE : 1991]**

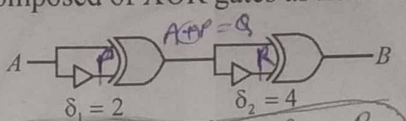
$AC+\bar{B}\bar{D}$

$f(A, B, C, D) = \Sigma\, d(3, 11, 12, 14) + \Sigma\, m(0, 2, 8, 10, 15)$

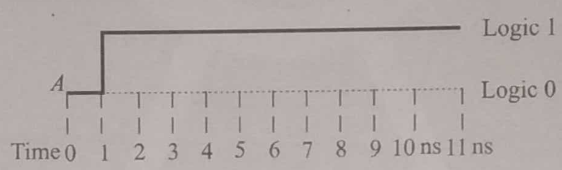
Where m and d denote the minterm and don't care respectively

$AC + \bar{B}\bar{D}$ Ans

Q.60 Consider the following circuit composed of XOR gates as non – inverting buffers. **[GATE : 2003]**



The non- inverting buffers have delays $\delta_1 = 2$ ns and $\delta_2 = 4$ ns 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

Q.61 A circuit outputs a digit in the form of 4 bits. 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 outputs 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? **[GATE : 2004]**

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

(A) 2 (B) 3 → 2 OR 1 AND (C) 4 (D) 5

Q.62 Let ⊕ and ⊙ denote the Exclusive OR and Exclusive NOR operations, respectively. Which one of the following is NOT CORRECT? **[GATE : 2018]**

(A) $\overline{P\oplus Q}=P\odot Q$

(B) $\bar{P}\oplus Q=P\odot Q$

(C) $\bar{P}\oplus\bar{Q}=P\oplus Q$

(D) $(P\oplus\bar{P})+Q=(P\odot\bar{P})\odot\bar{Q}$

Q.63 Which one of the following is Not a valid identity? **[GATE : 2019]**

(A) $(x\oplus y)\oplus z=x\oplus(y\oplus z)$

(B) $(x+y)\oplus z=x\oplus(y\oplus z)$

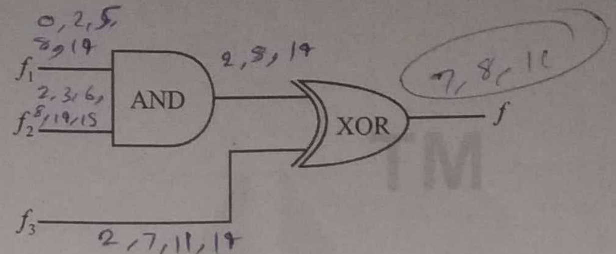
(B) $x\oplus y=x+y,\text{if } xy=0$

(C) $x\oplus y=(xy+x'y')'$

Q.64 Consider three 4-variable function $f_1, f_2,$ and f_3, which are expressed in sum-of –minterms as

$f_1 = \Sigma(0,2,5,8,14), f_2 = \Sigma(2,3,6,8,14,15), f_3 = \Sigma(2,7,11,14)$

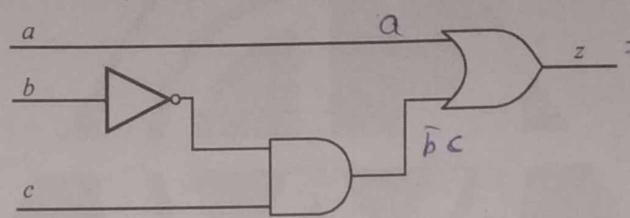
For the following circuit with one AND gate and one XOR gate, the output function f can be expressed as: **[GATE : 2019]**



(A) $\Sigma(7,8,11)$ (B) $\Sigma(2,7,8,11,14)$

(C) $\Sigma(2,14)$ (D) $\Sigma(0,2,3,5,6,7,8,11,14,15)$

Q.65 Consider the Boolean function $z(a,b,c)$. **[GATE : 2020]**



$= a + \bar{b}c$

a \ bc				
		1		
	1	1	1	1

Which one of the following minterm lists represents the circuit given above?

(A) $z = \sum(0,1,3,7)$ (B) $z = \sum(1,4,5,6,7)$

(C) $z = \sum(2,4,5,6,7)$ (D) $z = \sum(2,3,5)$

Chapter - 3 : K-Maps

Q.66 The function represented by the Karnaugh map given below is **[GATE : 1998]**

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

(A) A.B (B) AB + BC + CA (C) $\overline{B \oplus C}$ (D) A.BC

Q.67 Which of the following functions implements the Karnaugh map shown below? **[GATE : 1999]**

AB \ CD	00	01	11	10
00	0	0	1	0
01	X=0	X=0	1	X=0
11	0	1	1	0
10	0	1	1	0

→ CD

→ AD

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

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

Q.68 Given the following Karnaugh map, which one of the following represents the minimal Sum – Of-Products of the map? **[GATE : 2001]**

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

$\rightarrow \bar{y}z$

$\rightarrow xy$

(A) xy + y'z

(B) wx'y' + xy + xz

(C) w'x + y'z + xy

(D) xz + y

Q.69 Minimum SOP for f(w, x, y, z) shown in Karnaugh – map below is **[GATE : 2002]**

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

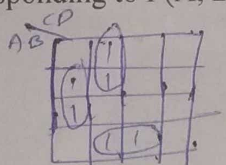
(A) x z + y' z

(B) x z' + z x'

(C) x' y + z x'

(D) None

Q.70 The switching expression corresponding to f (A, B, C, D) = Σ (1, 4, 5, 9, 11, 12) is: **[GATE : 2005]**



(A) $BC^1D^1 + A^1C^1D + AB^1D$

(B) $ABC^1 + ACD + B^1C^1D$

(C) $ACD^1 + A^1BC^1 + AC^1D^1$

(D) $A^1BD + ACD^1 + BCD^1$