**S.No. :** 07 **BS_CS_B_110919**

**Digital Logic**

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# CLASS TEST
# 2019-2020

## COMPUTER SCIENCE & IT

**Date of Test : 11/09/2019**

## ANSWER KEY ➤ Digital Logic

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **1.** | **(b)** | **7.** | **(c)** | **13.** | **(d)** | **19.** | **(d)** | **25.** | **(d)** |
| **2.** | **(a)** | **8.** | **(c)** | **14.** | **(b)** | **20.** | **(c)** | **26.** | **(c)** |
| **3.** | **(b)** | **9.** | **(c)** | **15.** | **(b)** | **21.** | **(d)** | **27.** | **(b)** |
| **4.** | **(d)** | **10.** | **(a)** | **16.** | **(a)** | **22.** | **(c)** | **28.** | **(b)** |
| **5.** | **(b)** | **11.** | **(a)** | **17.** | **(d)** | **23.** | **(c)** | **29.** | **(b)** |
| **6.** | **(c)** | **12.** | **(c)** | **18.** | **(c)** | **24.** | **(b)** | **30.** | **(b)** |

## DETAILED EXPLANATIONS

1. (b)

For every combination of x, y, z the function value remains same for input $\overline{x}, y, \overline{z}$.

| x y z | f(x, y, z) = f($\overline{x}$, y, $\overline{z}$) |
|---|---|
| 0 0 0 | either 0 or 1 |
| 1 0 1 | |
| 0 0 1 | either 0 or 1 |
| 1 0 0 | |
| 0 1 0 | either 0 or 1 |
| 1 1 1 | |
| 0 1 1 | either 0 or 1 |
| 1 1 0 | |

Effectively there are only four rows for the truth table of the function f (x, y, z).

∴ Total Boolean expressions possible is $2^4 = 16$.

2. (a)

$$(135)_x + (144)_x = (323)_x$$

$$\Rightarrow (x^2 + 3x + 5) + (x^2 + 4x + 4) = 3x^2 + 2x + 3$$

$$\Rightarrow \quad x^2 - 5x - 6 = 0$$

$$\Rightarrow \quad (x - 6)(x + 1) = 0$$

$$\Rightarrow \quad x = 6 \qquad [\because \text{ base of a number cannot be } -\text{ve}]$$

3. (b)

Let initial $Q_1 = Q_0 = 0$

| $J_0$ | $K_0$ | $J_1$ | $K_1$ | $Q_1$ | $Q_0$ |
|---|---|---|---|---|---|
| | | | | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 | 1 |
| 1 | 1 | 1 | 1 | 1 | 0 |
| 0 | 1 | 0 | 1 | 0 | 0 |

It is a mod-3 counter (00 → 01 → 10 → 00)

So, K = 3

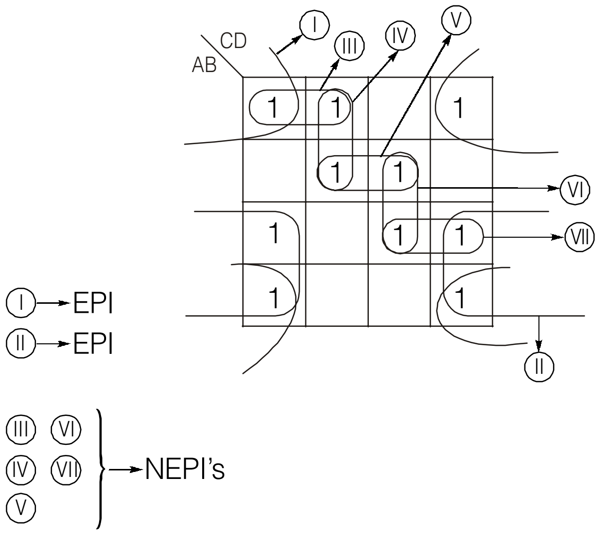
4. (d)

$$37 = 16 \times 2 + 5$$

After 37 clock pulses, the state of MOD-16 DOWN counter will be five states below the present state.

$$\begin{array}{r} 0110\,(6) \\ -\underline{0101(-5)} \\ 0001 \end{array}$$

5. (b)

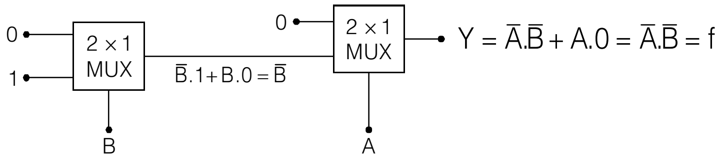


EPI = Essential Prime Implicant [which cover a minterm not covered by any other term]
NEPI = Non Essential Prime Implicant. Number of EPI's = 2, number of NEPI's = 5.

6. (c)

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

with 2 × 1 multiplexer



7. (c)

Range of signed 1's compliment number is $-2^{n-1} + 1$ to $2^{n-1} - 1$.

8. (c)

$$\begin{aligned}(AB + B\bar{C} + \bar{A}C)(A + C) &= AB + AB\bar{C} + ABC + \bar{A}C \\ &= AB(1 + \bar{C} + C) + \bar{A}C \\ &= AB + \bar{A}C\end{aligned}$$

9. (c)

Multiplexer is a combinational circuit, converts parallel to serial data and it selects one of the several inputs and transmits to a single output.

10. (a)

$$\begin{aligned}(x \oplus y) &= \bar{x}y + x\bar{y} \\ &= \overline{xy + \bar{x}\,\bar{y}} \\ &= \overline{0 + \bar{x}\,\bar{y}} \quad (\text{as } xy = 0) \\ &= (x + y)\end{aligned}$$

11. (a)

$$(36)_7 = 7 \times 3 + 6 = (27)_{10}$$

$$(67)_8 = 8 \times 6 + 7 = (55)_{10}$$

$$(98)_{10} = 9 \times 10 + 8 = (98)_{10}$$

$$(34)_5 = 3 \times 5 + 4 = (19)_{10}$$

$$\therefore \quad 27 + 55 + 98 + 19 = (199)_{10}$$

$$\begin{array}{r|l l} 9 & 199 & 1 \\ \hline 9 & 22 & 4 \\ \hline & 2 & \end{array} \Rightarrow (199)_{10} = (241)_9 = 241$$

12. (c)

$$f = \overline{\bar{A} + \overline{\left[B + \bar{C}(\overline{AB + A\bar{C}})\right]}}$$

$$= A \cdot \left[B + \bar{C}(\overline{AB + A\bar{C}})\right] \qquad \text{[Demorgan's Law]}$$

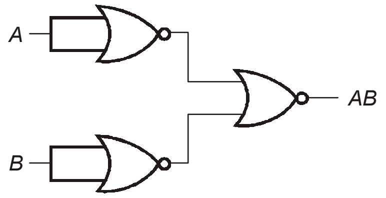
$$= A \cdot \left[B + \bar{C}(\overline{AB} \cdot \overline{A\bar{C}})\right] \qquad \text{[Demorgan's Law]}$$

$$= A \cdot \left[B + \bar{C}(\bar{A} + \bar{B})(\bar{A} + C)\right] \qquad \text{[Demorgan's Law]}$$

$$= A\left[B + \bar{C}(\bar{A} + \bar{B}C)\right] \qquad \text{[Distributive property]}$$

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

$= AB$ (AND gate to be implemented)



$\Rightarrow$ Minimum number of NOR gate required = 3

13. (d)

| Clock | $D$ | $Q_D$ | $T$ | $Q_T$ |
|---|---|---|---|---|
| - | 0 | 0 | 1 | 1 |
| 1 | 1 | 0 | 1 | 0 |
| 2 | 1 | 1 | 0 | 1 |
| 3 | 1 | 1 | 0 | 1 |
| 4 | 1 | 1 | 0 | 1 |

The circuit will be locked up in the state ‘11’. So state of circuit after 7 clock pulses is ‘11’.

14. (b)

$$\begin{aligned} T &\geq 3 \times 50 \text{ n sec} \\ T &\geq 150 \text{ n sec} \\ T_{min} &= 150 \text{ nsec} \\ f_{max} &= \frac{1 \times 10^9}{150} = 6.67 \text{ MHz} \end{aligned}$$

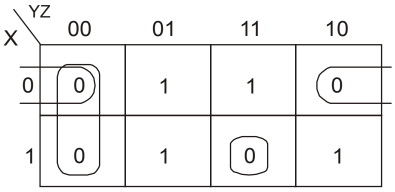
15. (b)

Total AND gates for a n-bit carry look ahead generator is $1 + 2 + 3 + \ldots + n = \frac{n(n+1)}{2}$

Here n = 5 $\Rightarrow$ $\frac{5(5+1)}{2} = 5 \times 3 = 15$

16. (a)

Let us consider active high input

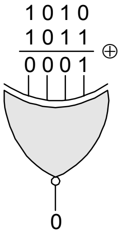


| X \ YZ | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 0 | 0 | 1 | 1 | 0 |
| 1 | 0 | 1 | 0 | 1 |

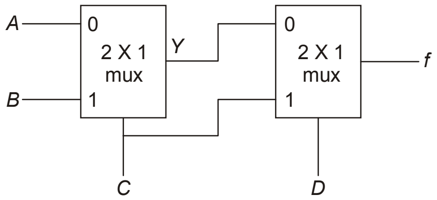
$$\begin{aligned} F &= \Sigma(1, 3, 5, 6) = \Pi\,(0, 2, 4, 7) \\ &= (Y + Z)\cdot(X + Z)\cdot(\overline{X} + \overline{Y} + \overline{Z}) \end{aligned}$$

17. (d)

In EX-NOR gate, if odd number of inputs are 1 then output is zero.



18. (c)



$$\begin{aligned} Y &= A\overline{C} + BC \\ f &= Y\overline{D} + CD \\ f &= (A\overline{C} + BC)\overline{D} + CD \;=\; A\overline{C}\overline{D} + BC\overline{D} + CD \end{aligned}$$

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

$$= AB\bar{C}\bar{D} + A\bar{B}\bar{C}\bar{D} + ABC\bar{D} + \bar{A}BC\bar{D} + ABCD + A\bar{B}CD + \bar{A}BCD + \bar{A}\bar{B}CD$$

$$f(A,B,C,D) = \Sigma m(3, 6, 7, 8, 11, 12, 14, 15)$$

$AB$ \ $CD$

| | | | |
|---|---|---|---|
| | | 1 | |
| | | 1 | 1 |
| 1 | | 1 | 1 |
| 1 | | 1 | |

19. (d)

$$f_1(A, B, C) = \Sigma(2, 3, 4)$$
$$f_2(A, B, C) = \pi(0, 1, 3, 6, 7) = \Sigma(2, 4, 5)$$

For function $f$ to be zero:

$$f_3(A, B, C) = \overline{[f_1(\text{A, B, C}) \cap f_2(\text{A, B, C})]}$$
$$= \Sigma(0, 1, 3, 5, 6, 7)$$

Maximum minterms possible are 6.

20. (c)

$$\text{Number of level-1 MUX} = \frac{4}{2} = 2$$

$$\Rightarrow \quad \text{Number of level-2 MUX} = \frac{2}{2} = 1$$

$$\therefore \quad \text{Total MUX required} = 3$$

21. (d)

| | | | | |
|---|---|---|---|---|
| $A =$ | | $a_2$ | $a_1$ | $a_0$ |
| $B =$ | | | $b_1$ | $b_0$ |
| $A \times B =$ | | $a_2b_0$ | $a_1b_0$ | $a_0b_0$ |
| | $b_1a_2$ | $b_1a_1$ | $b_1a_0$ | $\downarrow$ |
| | $b_1a_2$ | $(a_2b_0 + a_1b_1)$ | $(a_1b_0 + b_1a_0)$ | $a_0b_0$ |
| | $C_3$ | $C_2$ | $C_1$ | $C_0$ |

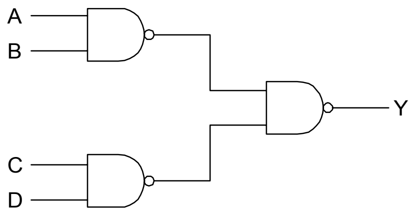
Number of AND gates required $X = 6$

Number of one bit full adders required $Y = 3$

$$X + Y = 6 + 3 = 9$$

22. (c)

$$Y = AB + CD = \overline{\overline{A.B}+\overline{C.D}}$$



23. (c)

Let the base of the system is B

$$9 \times 8 \times 5 = (190)_B$$
$$(360)_{10} = (190)_B$$
$$360 = B^2 + 9B + 0$$
$$B^2 + 9B - 360 = 0$$
$$B = 15, \qquad B = -24$$

Since base can not be negative.

$\Rightarrow$ Base $B = 15$

24. (b)

Decimal input = 92

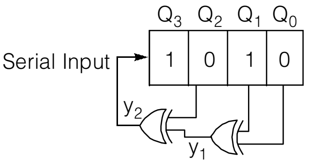
BCD = 10010010

Output of Gray code converter = 11011011

$Y_0$ corresponds to $I_m$ with $(S_n......S_0)$ is = $(11011011)_2$

$m = 219$

25. (d)



$y_1 = Q_1 \oplus Q_0$
$y_2 = y_1 \oplus Q_2$

| CLK pulse | | $Q_3$ | $Q_2$ | $Q_1$ | $Q_0$ |
|---|---|---|---|---|---|
| | 0 | 1 | 0 | 1 | 0 |
| 1 | 1 | 1 | 1 | 0 | 1 |
| 2 | 2 | 0 | 1 | 1 | 0 |
| 3 | 3 | 0 | 0 | 1 | 1 |
| 4 | 4 | 0 | 0 | 0 | 1 |
| 5 | 5 | 1 | 0 | 0 | 0 |
| 6 | 6 | 0 | 1 | 0 | 0 |
| 7 | 7 | 1 | 0 | 1 | 0 |

$$Q_3(t+1) = Q_0(t) \oplus Q_1(t) \oplus Q_2(t)$$

26. (c)

Consider characteristic equation of J-K Flip-Flop: $Q_{2N+1} = J\bar{Q}_{2N} + \bar{K}Q_{2N}$

$J = \bar{Q}_0 ; K = 1 \quad \Rightarrow \quad Q_{2N+1} = \bar{Q}_0 \bar{Q}_{2N}$ .....(*i*)

if $Q_0 = 1 \quad \Rightarrow \quad Q_{2N+1} = 0$

if $Q_0 = 0 \quad \Rightarrow \quad Q_{2N+1} = \bar{Q}_{2N}$

Consider characteristic equation of D – Flip-Flop: $Q_{N+1} = D$

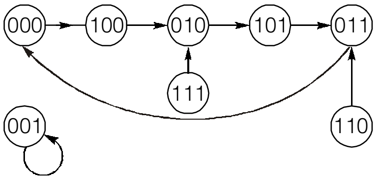
$Q_{N+1} = Q_2$ .....(*ii*)

Consider characteristic equation of T – Flip-Flop: $Q_{N+1} = T \oplus Q_N$

$Q_{N+1} = Q_1 \oplus Q_0$ .....(*iii*)

Using equations (*i*), (*ii*) and (*iii*)

| Present State | | | Next State | | |
|---|---|---|---|---|---|
| $Q_2$ | $Q_1$ | $Q_0$ | $Q_2$ | $Q_1$ | $Q_0$ |
| 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 1 |
| 0 | 1 | 0 | 1 | 0 | 1 |
| 0 | 1 | 1 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 1 | 0 |
| 1 | 0 | 1 | 0 | 1 | 1 |
| 1 | 1 | 0 | 0 | 1 | 1 |
| 1 | 1 | 1 | 0 | 1 | 0 |



The number of used states = 5

∴ Modulus value of the counter = 5

27. (b)

$$\begin{aligned} A &= (EC)_{16} \rightarrow (1032)_6 \\ B &= (20)_{10} \rightarrow (32)_6 \\ C &= (15)_8 \rightarrow (21)_6 \\ S &= A + B + C \qquad \text{(add in base-6 and convert into base-10)} \\ &= (1085)_{10} \end{aligned}$$

28. (b)

To obtain a JK flip-flop from a T flip-flop, we first construct the characteristic table of JK flip-flop; and then obtain the excitation values for the T flip-flop as shown below:

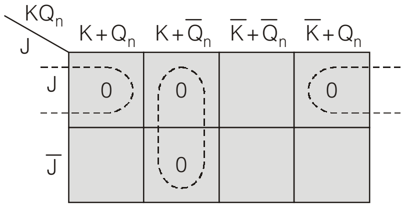
| J | K | $Q_n$ | $Q_{n+1}$ | T |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 1 | 0 |
| 0 | 1 | 0 | 0 | 0 |
| 0 | 1 | 1 | 0 | 1 |
| 1 | 0 | 0 | 1 | 1 |
| 1 | 0 | 1 | 1 | 0 |
| 1 | 1 | 0 | 1 | 1 |
| 1 | 1 | 1 | 0 | 1 |

Characteristic table of JK flip flop

Excitation values for T flip-flop

Now, assuming T to be an output, we solve it in terms of J, K, $Q_n$ inputs. This gives the definition of the logic to be applied on the T input.

Also, observing the given options, we solve for T using a maxterms map instead of using a minterms map, as shown below:



$$T = (J+Q_n)\cdot(K+\bar{Q}_n)$$

The circuit corresponding to this expression is given option (b).

29. (b)

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

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

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

$$F = A \oplus C$$

30. (b)

$D_1 = Q_0$, $D_0 = Q_0 \odot Q_1$

$\Rightarrow (Q_1\,Q_0)\ 00 \rightarrow 01 \rightarrow 10 \rightarrow 00 \rightarrow 01 \ldots$

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