

Combinational Logic Design Using MSI Circuits

ONE-MARK QUESTIONS

- 6.1 The truth table for the given circuit is

X_2	X_1	X_0	Decoder Output	Encoder Input	Y_2	Y_1	Y_0
0	0	0	OP_0	IP_0	0	0	0
0	0	1	OP_1	IP_1	0	0	1
0	1	0	OP_2	IP_3	0	1	1
0	1	1	OP_3	IP_2	0	1	0
1	0	0	OP_4	IP_6	1	1	0
1	0	1	OP_5	IP_7	1	1	1
1	1	0	OP_6	IP_4	1	0	0
1	1	1	OP_7	IP_5	1	0	1

If we observe at the input and output bit pattern relationship, it is similar to the gray to binary converter except for last two entries. None of the other options closely match with it. So, option 'a' is the most appropriate answer.

- 6.2 After closely inspecting given circuit it is clear that input P is fed to both decoders without any logic operation and hence input data D_{in} can be applied to this terminal. Terminals R and S are used to select one of the four outputs whereas, Q is true for the upper decoder and untrue for the lower decoder. Hence, S_2, S_0, S_1 inputs must be connected to Q, R and S inputs, respectively. Therefore, option 'd' is correct.
- 6.3 We've studied the expressions for difference and borrow output of the half subtractor in this Chapter. So, we can directly state that the correct option is 'c'.
- 6.4 Say Y is the output of the first mux. So, we can write
 $Y = S_1 \bar{W} + \bar{S}_1 W = S_1 \oplus W$. Similarly, $F = S_2 \bar{Y} + \bar{S}_2 Y = S_2 \oplus Y$.
 $\therefore F = W \oplus S_1 \oplus S_2$ i.e. option 'd'.
- 6.5 One can write truth table of the 2-bit comparator as given in Table 6.8 and state that there exist 6 possible combinations wherein $A > B$. So, the correct option is 'b'.

TWO-MARK QUESTIONS

- 6.1 The output of the first mux is 1 for odd number of 1's applied on U and V inputs. So, its output expression is $U \oplus V$. This output is fed as input to second mux whose output is zero when $W = 1$ and it is same as that of the first mux output when $W = 0$. Therefore, we can write it as $(\bar{U}V + U\bar{V})\bar{W}$ which is nothing but option 'c'.
- 6.2 The C0 and C1 inputs of the decoder are used to enable one of the tri-state buffers connected on the 4 inputs P, Q, R and S. But there is only one output Y. Hence, it is a 4:1 mux circuit and option 'b' is correct.

- 6.3** When $T = 0$, the input will have to travel through the critical path. It will begin at Q and R inputs and terminate at output terminal Y. Therefore, we can write

$$T_{\text{critical}} = T_{\text{NOR}} + T_{\text{Mux}} + T_{\text{Mux}} = 2 \text{ ns} + 1.5 \text{ ns} + 1.5 \text{ ns} = 5 \text{ ns}.$$

- 6.4** Example 6.2 is repeated in GATE exam. Only different literals are used. So, please refer to it and here also correct option is 'c'.

- 6.5** In ripple carry adder the sum is dependent on the present inputs A_n , B_n and carry output of the previous stage (i.e C_{n-1}). But input A_n and B_n are applied at the same time and to obtain correct result one has to wait for C_{n-1} input. In this example, there are 15 stages through which carry will ripple before reaching the FA_{15} . It is given that carry-propagation delay of each FA is 12 ns. Therefore, carry C_{14} will reach to FA_{15} after time $12 \text{ ns} \times 15 = 180 \text{ ns}$. Next, FA_{15} will require sum-propagation delay of 15 ns to produce correct result. Therefore, S_{15} will be produced at $15 + 180 = 195 \text{ ns}$ and carry C_{15} will be produced at $12 \text{ ns} \times 16 = 192 \text{ ns}$. This means the worst delay is required to produce S_{15} output and it is 195 ns.

- 6.6** The logic expression at the output of mux can be written as

$$F = \bar{A}\bar{B}I_0 + \bar{A}BI_1 + A\bar{B}I_2 + ABI_3$$

Now substituting I_0 through I_3

$$\therefore F = \bar{A}\bar{B}C + \bar{A}BD + A\bar{B}\bar{C} + ABC\bar{D}$$

Now converting this expression in the standard canonical format

$$\therefore F = \bar{A}\bar{B}C(D + \bar{D}) + \bar{A}BD(C + \bar{C}) + A\bar{B}\bar{C}(D + \bar{D}) + ABC\bar{D}$$

$$\therefore F = \bar{A}\bar{B}CD + \bar{A}\bar{B}C\bar{D} + \bar{A}BCD + \bar{A}B\bar{C}D + A\bar{B}\bar{C}D + A\bar{B}C\bar{D} + ABC\bar{D}$$

$$\therefore F(A, B, C, D) = \Sigma m(2, 3, 5, 7, 8, 9, 12) \quad \text{i.e. correct option is 'd'}.$$