Question 1 (50 points - 2.5 points each)

Select the correct answer:

01. $(75)_{10}$ is:

a) $(01110101)_2$ b) $(11101010)_2$ c) $(10101110)_3$

d) $(1001011)_2$ e) $(01011010)_2$

02. $(10110001101011.11110010)_2$ is:

a) $(B1A3.F2)_{16}$ b) $(2C6B.F2)_{16}$ c) $(58D3.F2)_{16}$

d) $(2301223.3302)_{16}$ e) None of the above

03. $(153.513)_{10}$ is:

a) $(231.4065)_8$ b) $(123.6540)_8$ c) $(132.4065)_8$

d) $(213.6540)_8$ e) $(231.613)_8$

04. Using binary code (2421), number 5 can be represented as:

a) (1011) b) (0101) c) (1010)

d) (a) and (b) e) (a) and (c)

05. The base x of the numbers in the operation $((24)_x + (17)_x = (40)_x)$ is:

a) 10 b) 11 c) 12

d) 13 e) None of the above

06. The simplest form of $F = y(x+y) + (x+y)'z + yz$ is:

a) $F = 1$ b) $F = y$ c) $F = x'z$

d) $F = y + x'z$ e) $F = y + yz + x'z$

07. Given $F(x, y, z) = \prod(0, 3, 4, 7)$ and G is the complement of F, then:

a) $G(x, y, z) = \sum(0, 1, 2, 3, 5, 7)$

b) $G(x, y, z) = \prod(0, 3, 4, 7)$

c) $G(x, y, z) = \sum(1, 2, 5, 6)$

d) $G(x, y, z) = \sum(0, 3, 4, 7)$

e) None of the above

08. The largest decoder we can build using five 2-to-4 decoders with Enable input without any additional component is:

a) 3-to-8 decoder b) 4-to-16 decoder c) 5-to-32 decoder

d) 6-to-64 decoder e) None of the above

09. If a function $F(x, y, z) = x(y'z' + yz)$ then the dual of F is:

a) $x' + (y + z)(y' + z')$

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

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

d) 1

e) None of the above

10. When we express the function $F = xy + x'z$ as a product of maxterms, the result will be:

a) $F = \prod(0, 1, 2, 6, 7)$

b) $F = \prod(0, 2, 4, 5)$

c) $F = \sum(1, 3, 6, 7)$

d) $F = \prod(2, 3)$

e) None of the above

11. Circle *all* functions that are expressed in a non-standard form:

a) $F = y' + xy + x'yz'$

b) $F = \prod(0, 2, 7)$

c) $F = \sum(0, 2, 6, 7)$

d) $F = AB + C(D + E)$

e) $F = x(y' + z)(x' + y + z')$

12. Consider the following combinational function block involving four Boolean variables x, y, a, b where x, a, b are inputs and y is the output.

```
f (x, y, a, b)
{
    if (x is 1) y = a;
    else y = b;
}
```

Which one of the following digital logic blocks is the most suitable for implementing this function?

a) Full adder

b) Priority encoder

c) Multiplexer

d) Decoder

e) Half-adder

13. A logic circuit has two 3-bit unsigned inputs X and Y (e.g. X and Y are each composed of 3 bits). The logic circuit has also an output number $Z = \sqrt{X^2 + Y^2}$. The minimum number of bits required for the integer part of the output number Z is:

a) 6

b) 5

c) 3

d) 4

e) 2

14. The result of the Boolean expression simplification for $(B \oplus C) + (AB)'(A' + C')'$ is:

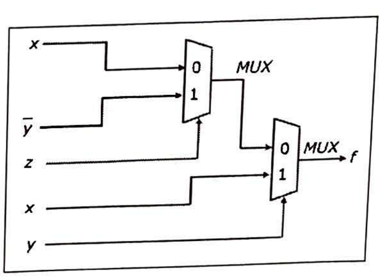
a) $A \oplus C$

b) $B \oplus C$

c) $(B \oplus C)'$

d) $(A \oplus B)'$

e) None of the above



15. Consider the circuit in the next Figure. Which one of the following options correctly represents $f(X, Y, Z)$?:

a) $x + y'z$

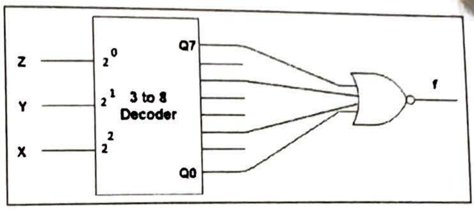
b) $xz' + xy + (yz)'$

c) $xz + xy + (yz)'$

d) $xz + xy' + y'z$

e) None of the above

16. What Boolean function does the next circuit realize?:



a) $xz + x'z'$ b) $xz' + x'z$ c) $x'y' + yz$

d) $xy + y'z'$ e) None of the above

17. A multiplexor with a 8-bit data input has:

a) 1 output line, 4 select lines

b) 1 output line, 3 select lines

c) 2 output lines, 3 select lines

d) 4 output lines, 2 select lines

e) None of the above

m7 + m5 + m2 + m6

X Z + X'Z'

18. When multiplying a 6-bit binary number (muliplicand) by a 5-bit binary number (multiplier), the following number of digital components are required:

a) 25 AND gates, 2 OR gates, 2 4-bit binary adders

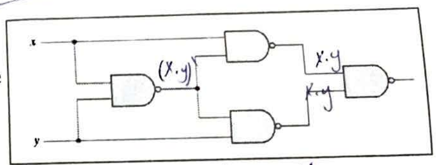
b) 16 AND gates, 16 OR gates

c) 30 AND gates, 4 (5-bit) binary adders

d) 30 AND gates, 4 (6-bit) binary adders

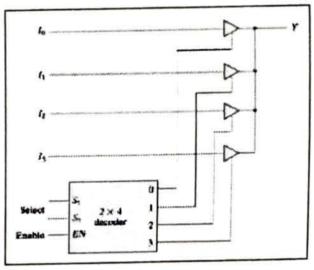
e) 16 AND gates, 14 OR gates, 2 (5-bit) binary adders

19. *Consider the circuit in the next Figure. Which one of the following options correctly represents the output?:*



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

d) $x \oplus y$ e) None of the above



20. The expression of Y as function of the inputs is as follows:

a) High impedance or $[EN(I_0 + I_1 + I_2 + I_3)]$

b) High impedance or $[EN'(I_0S_0'S_1' + I_1S_0S_1' + I_2S_0'S_1 + I_3S_0S_1)]$

c) High impedance or $[EN + I_0 + I_1 + I_2 + I_3]$

d) High impedance or $[EN(I_0S_0'S_1' + I_1S_0S_1' + I_2S_0'S_1 + I_3S_0S_1)]$

e) None of the above

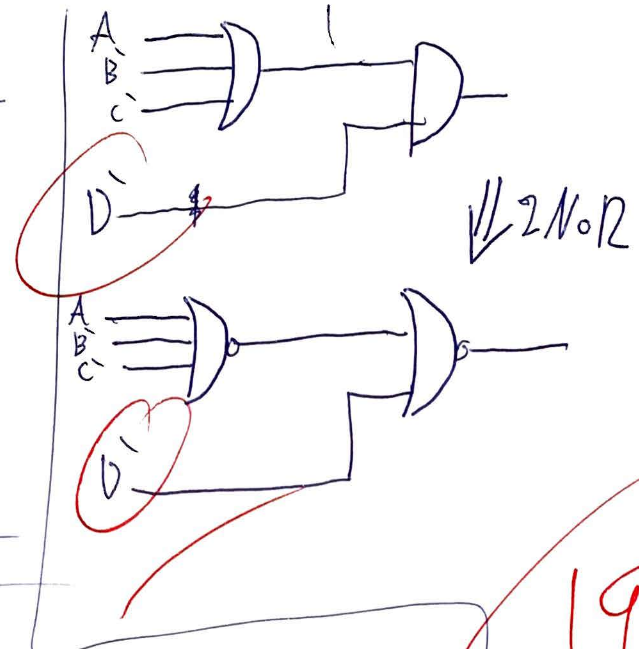
Question 2 (20 points)

Implement the following Boolean function F, together with the don't-care conditions d, using no more than two NOR gates:

$$F(A,B,C,D) = \sum(2,4,10,12,14)$$
$$d(A,B,C,D) = \sum(0,1,5,8)$$

Assume that both the normal and complement inputs are available.

A	B	C	D	F
0	0	0	0	X
0	0	0	1	X
0	0	1	0	1
0	0	1	1	0
0	1	0	0	1
0	1	0	1	X
0	1	1	0	0
0	1	1	1	0
1	0	0	0	X
1	0	0	1	0
1	0	1	0	1
1	0	1	1	0
1	1	0	0	1
1	1	0	1	0
1	1	1	0	1
1	1	1	1	0

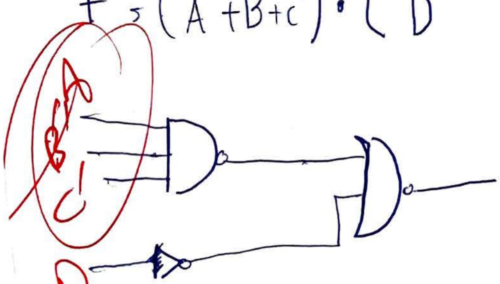


19

NOR(Maxterm)

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

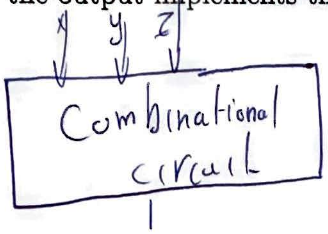
$F = (A + B' + C') \cdot (D')$



Question 3 (10 points)

Write the truth table for a combinational circuit that takes three inputs, x, y and z and that behaves as follows:

- If the input if less that 6, the integer part of the output implements $F = \sqrt{3 \times \text{input}}$
- Otherwise, the output implements the integer part of the function $F = \sqrt{2 \times \text{input}}$



Question 4 (20 points)

1. Implement the Boolean function $F = xy + x'z + x'y'$ using a single 2×1 MUX. Use external components if needed.

2. Implement the same Boolean function using 2×4 decoders with Enable input bit. Use external components if needed.

$F = xy + x'z + x'y'$

$= xyz + xyz' + x'yz + x'y'z + x'y'z + x'y'z'$

$m_7 + m_6 + m_3 + m_1 + m_1 + m_0$

$= \Sigma(0, 1, 3, 6, 7)$

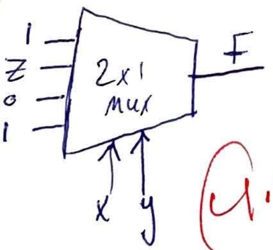
x	y	z	F	
0	0	0	1	F = 1
0	0	1	1	
0	1	0	0	F = z
0	1	1	1	
1	0	0	0	F = 0
1	0	1	0	
1	1	0	1	F = 1
1	1	1	1	

(6)

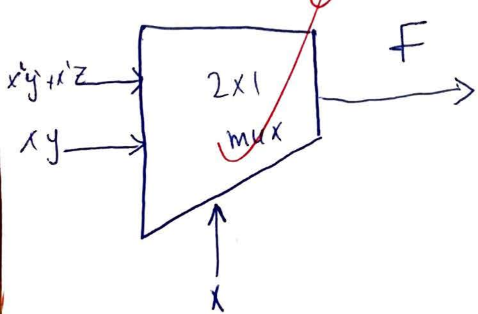
$F = x'y' + x'z$

$F = xy$

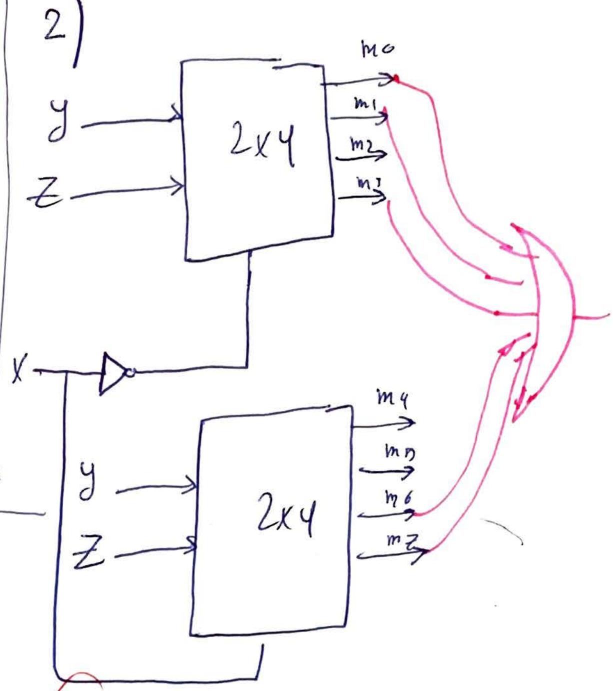
1)



(4.5)



2)



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