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Logic design (2017 fall)

Quiz # 4

Name:_____ID:_____

1. A combinational circuit has four binary inputs (A, B, C, D) and three binary outputs (X, Y, Z).
   XYZ represents a binary number whose value equals the number of 0s at the input.
   For example, if $ABCD = 1011$ then $XYZ = 001$.
   (a) (15%) Complete the true table for the circuit.
   (b) (15%) Find the minterm expansion for Z using m-notation.
   (c) (15%) Find the maxterm expansion for Y using M-notation.
   Note that the order of the input variables for m-notation and M-notation is $ABCD$.

ABCD	X	Y	Z
0000	**1**	**0**	**0**
0001	**0**	**1**	**1**
0010	**0**	**1**	**1**
0011	**0**	**1**	**0**
0100	**0**	**1**	**1**
0101	**0**	**1**	**0**
0110	**0**	**1**	**0**
0111	**0**	**0**	**1**
1000	**0**	**1**	**1**
1001	**0**	**1**	**0**
1010	**0**	**1**	**0**
1011	0	0	1
1100	**0**	**1**	**0**
1101	**0**	**0**	**1**
1110	**0**	**0**	**1**
1111	**0**	**0**	**0**

$\mathbf{Z = m(1, 2, 4, 7, 8, 11, 13, 14)}$

$\mathbf{Y = M(0, 7, 11, 13, 14, 15)}$

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2. Fig.1 shows a circuit performing binary subtraction between two 4-bit unsigned binary integers X($x_3x_2x_1x_0$) and Y($y_3y_2y_1y_0$). When X is larger or equal to Y, the 4-bit output D ($d_3d_2d_1d_0$) will be equal to the difference of subtracting Y from X and the other output bor_4 will be equal to 0. When X is smaller than Y, the output bor_4 will be 1. This subtraction circuit is designed by serially connecting 4 full subtractors. Fig.2 shows the functionality of a full subtractor with 3 inputs (x, y, bor_{in}) and two outputs (d, bor_{out}).
   (a) (25%) Complete the true table of a full subtractor shown below.
   (b) (15%) Find the minterm expansions for the output d of the full subtractor.
   (c) (15%) Find the maxterm expansions for the output bor_{out} of the full subtractor.

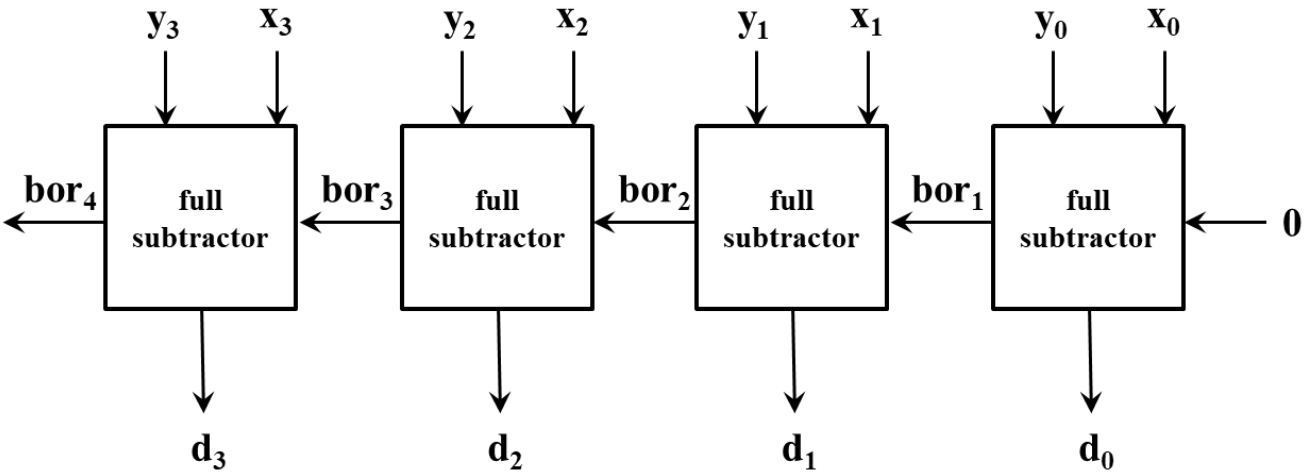
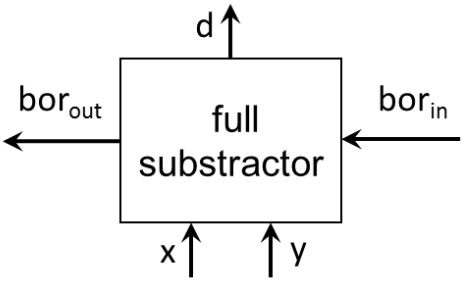


Fig.1



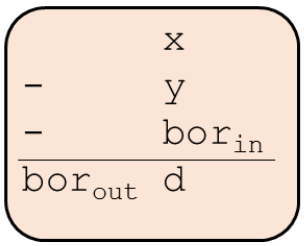


Fig.2

x	y	bor_{in}	d	bor_{out}
0	0	0	**0**	**0**
0	0	1	1	1
0	1	0	**1**	**1**
0	1	1	**0**	**1**
1	0	0	**1**	**0**
1	0	1	**0**	**0**
1	1	0	**0**	**0**
1	1	1	**1**	**1**

Truth table

$$\mathbf{d = m(1,2,4,7) = x'y'bor_{in} + x'ybor_{in}' + xy'bor_{in}' + xybor_{in}}$$

$$\mathbf{bor_{out} = \prod M(0,4,5,6) = (x + y + bor_{in})(x' + y + bor_{in})(x' + y + bor_{in}')(x' + y' + bor_{in})}$$