Homework 12 - Solution

Due at the beginning of your scheduled lab period

1. [8 pts] Draw a circuit that multiplies a 5-bit unsigned binary number X4 X3 X2 X1 X0 by a 3-bit unsigned binary number Y2 Y1 Y0, using an array of full-adder cells. Determine the *worst case propagation delay* if each full adder takes 10 ns to produce its C and S outputs, and each AND gate (used to generate the product components) has 5 ns of propagation delay.

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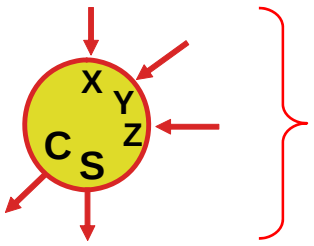
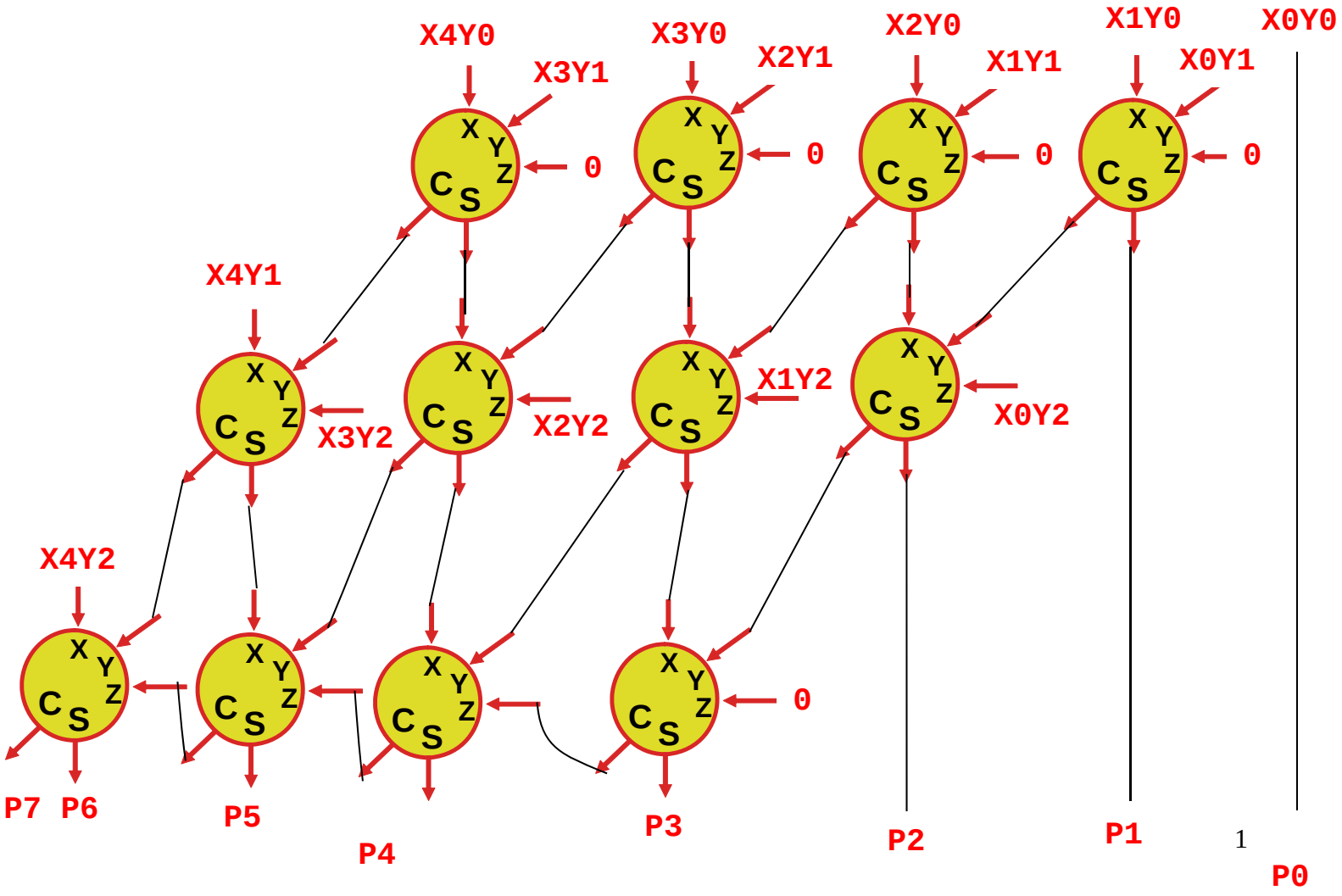
                X4    X3    X2    X1    X0
                  ×   Y2    Y1    Y0
          ------------------------------------
                    X4Y0  X3Y0  X2Y0  X1Y0  X0Y0
              X4Y1  X3Y1  X2Y1  X1Y1  X0Y1
        X4Y2  X3Y2  X2Y2  X1Y2  X0Y2
          ------------------------------------
        P7    P6    P5    P4    P3    P2    P1    P0
```



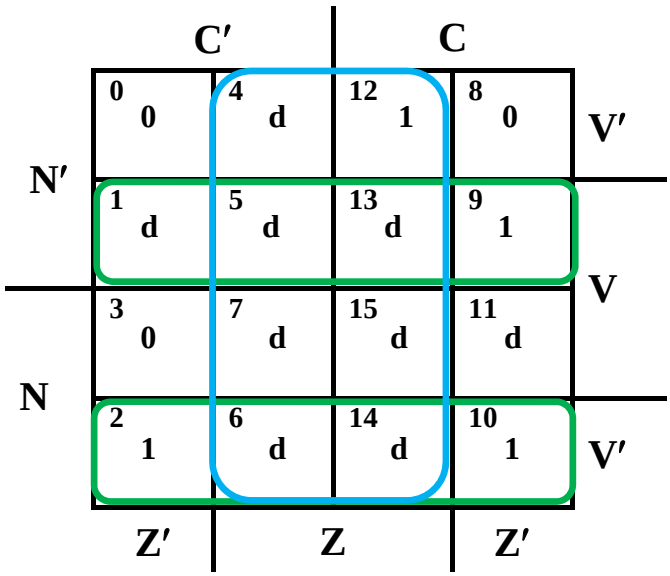
full adder cell to use

Array should have 4 diagonals/3 rows (12 FA cells total, plus 15 AND gates); worst case delay path is 65 ns



2. [6 pts] Complete the magnitude comparator chart below and derive the function for "A *less than or equal to* B" ("ALEB") in its simplest (minimal) form, assuming that A and B are *signed two's complement numbers*.

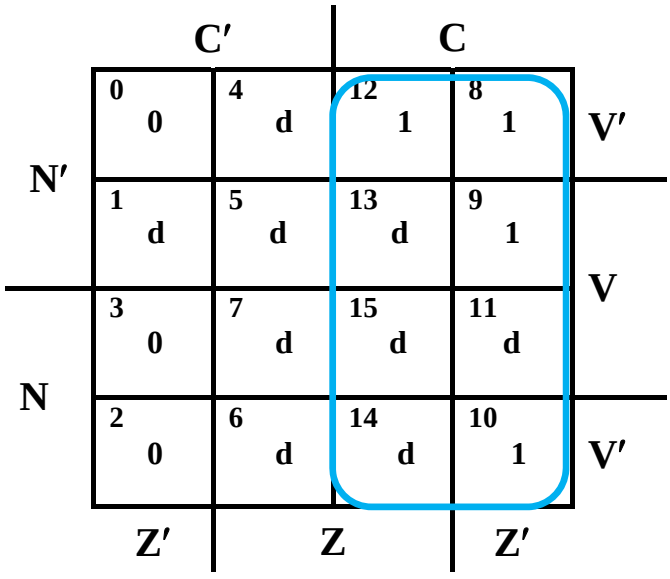
A_1	A_0	(A)	B_1	B_0	(B)	?	C	Z	N	V
0	0	0	0	0	0	(A) = (B)	1	1	0	0
0	0	0	0	1	+1	(A) < (B)	0	0	1	0
0	0	0	1	0	-2	(A) > (B)	0	0	1	1
0	0	0	1	1	-1	(A) > (B)	0	0	0	0
0	1	+1	0	0	0	(A) > (B)	1	0	0	0
0	1	+1	0	1	+1	(A) = (B)	1	1	0	0
0	1	+1	1	0	-2	(A) > (B)	0	0	1	1
0	1	+1	1	1	-1	(A) > (B)	0	0	1	1
1	0	-2	0	0	0	(A) < (B)	1	0	1	0
1	0	-2	0	1	+1	(A) < (B)	1	0	0	1
1	0	-2	1	0	-2	(A) = (B)	1	1	0	0
1	0	-2	1	1	-1	(A) < (B)	0	0	1	0
1	1	-1	0	0	0	(A) < (B)	1	0	1	0
1	1	-1	0	1	+1	(A) < (B)	1	0	1	0
1	1	-1	1	0	-2	(A) > (B)	1	0	0	0
1	1	-1	1	1	-1	(A) = (B)	1	1	0	0



ALEB = Z + N′•V + N•V′

3. [6 pts] Complete the magnitude comparator chart below and derive the function for "A *higher than or same* B" ("AHSB") in its simplest (minimal) form, assuming that A and B are *unsigned numbers*.

A_1	A_0	(A)	B_1	B_0	(B)	?	C	Z	N	V
0	0	0	0	0	0	(A) = (B)	1	1	0	0
0	0	0	0	1	+1	(A) < (B)	0	0	1	0
0	0	0	1	0	+2	(A) < (B)	0	0	1	1
0	0	0	1	1	+3	(A) < (B)	0	0	0	0
0	1	+1	0	0	0	(A) > (B)	1	0	0	0
0	1	+1	0	1	+1	(A) = (B)	1	1	0	0
0	1	+1	1	0	+2	(A) < (B)	0	0	1	1
0	1	+1	1	1	+3	(A) < (B)	0	0	1	1
1	0	+2	0	0	0	(A) > (B)	1	0	1	0
1	0	+2	0	1	+1	(A) > (B)	1	0	0	1
1	0	+2	1	0	+2	(A) = (B)	1	1	0	0
1	0	+2	1	1	+3	(A) < (B)	0	0	1	0
1	1	+3	0	0	0	(A) > (B)	1	0	1	0
1	1	+3	0	1	+1	(A) > (B)	1	0	1	0
1	1	+3	1	0	+2	(A) > (B)	1	0	0	0
1	1	+3	1	1	+3	(A) = (B)	1	1	0	0



AHSB = C

Score: _____ / 20