Homework 12
Due at the beginning of your scheduled lab period

Last Name (Printed): _____ Lab Div: _____ Date: _____

E-mail: __ __ __ __ __ __ __ __ @purdue.edu Signature: _____

*Printed copies of these pages along with your original (**hand-annotated**, **not photocopied**) written solution in the space provided (unless otherwise indicated) are required in order to receive credit. NOTE: The purpose of homework is to provide an opportunity for practicing the kinds of problems you will be asked to solve on quizzes and exams – **copying the work of someone else does not accomplish this.***

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
_____
```

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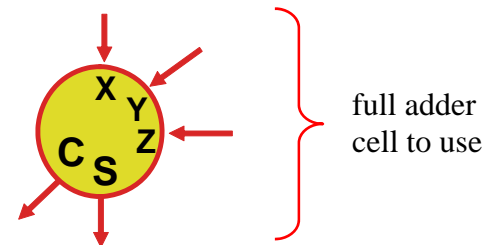
2. [6 pts] Complete the magnitude comparator chart below and derive the function for "A *less than or equal to* B" ("ALEB") in its simplest (minimal) form, assuming that A and B are *signed numbers*.

A$_1$	A$_0$	(A)	B$_1$	B$_0$	(B)	?	C	Z	N	V
0	0	0	0	0	0	(A) = (B)				
0	0	0	0	1	+1	(A) < (B)				
0	0	0	1	0	-2	(A) > (B)				
0	0	0	1	1	-1	(A) > (B)				
0	1	+1	0	0	0	(A) > (B)				
0	1	+1	0	1	+1	(A) = (B)				
0	1	+1	1	0	-2	(A) > (B)				
0	1	+1	1	1	-1	(A) > (B)				
1	0	-2	0	0	0	(A) < (B)				
1	0	-2	0	1	+1	(A) < (B)				
1	0	-2	1	0	-2	(A) = (B)				
1	0	-2	1	1	-1	(A) < (B)				
1	1	-1	0	0	0	(A) < (B)				
1	1	-1	0	1	+1	(A) < (B)				
1	1	-1	1	0	-2	(A) > (B)				
1	1	-1	1	1	-1	(A) = (B)				

	C'		**C**		
	0	4	12	8	**V'**
N'					
	1	5	13	9	
					V
	3	7	15	11	
N					
	2	6	14	10	**V'**
	Z'	**Z**		**Z'**	

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)				
0	0	0	0	1	+1	(A) < (B)				
0	0	0	1	0	+2	(A) < (B)				
0	0	0	1	1	+3	(A) < (B)				
0	1	+1	0	0	0	(A) > (B)				
0	1	+1	0	1	+1	(A) = (B)				
0	1	+1	1	0	+2	(A) < (B)				
0	1	+1	1	1	+3	(A) < (B)				
1	0	+2	0	0	0	(A) > (B)				
1	0	+2	0	1	+1	(A) > (B)				
1	0	+2	1	0	+2	(A) = (B)				
1	0	+2	1	1	+3	(A) < (B)				
1	1	+3	0	0	0	(A) > (B)				
1	1	+3	0	1	+1	(A) > (B)				
1	1	+3	1	0	+2	(A) > (B)				
1	1	+3	1	1	+3	(A) = (B)				

	C′		C		
	0	4	12	8	V′
N′	1	5	13	9	
	3	7	15	11	V
N	2	6	14	10	V′
	Z′	Z		Z′	

Score: _____ / 20