Name: ____

CS/CoE 0447 – Spring 2017

Lab 7: Booth’s Encoding, Booth’s Multiplication Algorithm, and Restoring Division

Each of you should submit your own solution. If you choose to work with a neighbor/partner, put your partner’s name in the appropriate place on CourseWeb. Late submissions will not be accepted.

To help you practice for an upcoming exam, consider working each problem in pen or pencil on a hard copy of this document. Then, **enter your answers into CourseWeb.**

1. Convert each of the following 8-bit two’s complement binary numbers into 8-bit Booth’s encoding:

a. 1111 1110	b. 1010 1010	c. 0010 0001

2. Decode each of the following 4-bit binary Booth’s-encoded numbers into decimal:

a. **0-11-1**	b. 10-10	c. **1-100**

3. Convert each of the following decimal numbers into 8-bit binary numbers in Booth’s encoding:

a. –7	b. –32	c. 15

4. Show the steps for multiplying the 8-bit operands 0011 1110 and 0110 0101 (both are signed) using **Booth's Algorithm** (http://people.cs.pitt.edu/~childers/CS0447/lectures/multiplication.pdf). Hint: Because multiplication is commutative, you may strategically choose one of the two operands to be the multiplier to minimize the number of additions and subtractions.

Populate the cells of the following table. Do each addition or subtraction operation **within the table**.

Iteration	Multiplicand	**Booth's Algorithm**	
		Step	Product Register (17 bits)
0			
1			
2			
3			
4			
5			
6			
7			
8			

FINAL PRODUCT:

0110 0101 × 0011 1110 = 0011 1110 × 0110 0101 (signed) = ________________________________

5. Show the steps for dividing the dividend 1001 1010$_b$ by the divisor 0000 0100$_b$ (both **unsigned**) using **restoring division** for Hardware Design 3. Restoring division is described online, with an example, at https://people.cs.pitt.edu/~childers/CS0447/lectures/division.pdf.

Populate the cells of the following table. Within it, **show your work** for each addition/subtraction.

		Restoring Division (Hardware Design 3)	Remainder Register (16 bits)	
Iteration	Divisor (8 bits)	Step	Remainder (8 bits)	Dividend (8 bits)
0		Initial values		
1				
2				
3				
4				
5				
6				
7				
8				
Done				

FINAL RESULT: 1001 1010b ÷ 0000 0100$_b$ = ____________________________