COE 0147 Spring 2014
Lab #7: Multiplication and Division

Each of you should submit your own solution, according to the instructions at your TA's website. Each person must turn in their own copies of the lab. If you choose to work with a neighbor/partner, put your partner's name on your submitted copy of the lab.
For the written part, you should turn in a hard copy of this assignment at the beginning of the following recitation meeting either in recitation class or in your TA's mailbox. Staple multiple pages together and do not forget to put your name on. Do not present answers out of order.

1. Perform three subtractions on 9-bit 2's complement binary numbers as follows:
    a) 195 - 47
    b) 87 - 59
    c) -46 – 71

For each of these subtractions, convert the numbers into 9-bit 2's complement, add those and convert the resultant binary 2's complement number into decimal form. Show all your work.

2. Show the steps for the multiplication of 10010101b and 10101111b (**unsigned**) using **Hardware Design 3** (http://www.pitt.edu/~kmram/CoE0147/lectures/numbers3.pdf).
Here 10010101b is the multiplicand and 10101111b is the multiplier.

Draw a table and fill up the columns:

Iteration	Multiplicand	Implementation 3	
		Step	Product(16-bit)
0			
1			
2			
3			
4			
5			
6			
7			
8			

Show your work (addition of product and multiplicand in each iteration) on the next page.

Show your work on problem 2 on this page

3. Convert the following 8-bit binary numbers into Booth's encoding form:

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01010011, 11010101, 01000001
```

4. Convert the following decimal numbers into 9-bit binary numbers in Booth's encoding form:

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25, −201, −48
```

5. Show the steps for the multiplication of 10010101b and 10101111b (**signed**) using **Booth's algorithm** (http://www.pitt.edu/~kmram/CoE0147/lectures/numbers3.pdf).
Here 10010101b is the multiplicand and 10101111b is the multiplier.

Draw a table and fill up the columns:

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

Show your work (addition of product and multiplicand in each iteration) on the next page.

Show your work on problem 5 on this page

6. Show the steps for the multiplication of 01100001b and 01011011b (signed) using Booth's algorithm (available here: http://www.pitt.edu/~kmram/CoE0147/lectures/numbers3.pdf). Here 01100001b is the multiplicand and 01011011b is the multiplier. Draw a table similar to the following one and fill up the columns:

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

Show your work on problem 6 on this page

7 In a table similar to the following one, show the steps for computing 00111000b (the dividend) divided by 0011b (the divisor, both numbers are unsigned) using **non-restoring division**. Non-restoring division is described online at: http://www.pitt.edu/~kmram/CoE0147/lectures/division.pdf. An example of doing non-restoring division is also shown.

Iteration	Step (description)	Divisor (4 bits)	Dividend (8 bits)	Remainder Register (8 bits)

Show your work on problem 7 on this page