COE 0147

# Lab 7: Multiplication

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**For this lab, either**

1. **Submit a paper copy due at next recitation**
2. **Scan (or a high quality picture) and upload to courseweb, check courseweb due date**
3. **Type in answers nicely and upload to courseweb**

**Important: For the multiplications, most of the points are for the individual steps, not the final answer (that is, don’t just write down the answer and fake the intermediate steps!)**

1. Solve the following 9-bit 2’s complement binary subtractions:

• 144 - 28 = ?

• 92 - 43 = ?

• -32 - 84 = ?

For each of these subtractions, convert the numbers into 9-bit 2’s complement, add them together, and convert the resultant binary 2’s complement number into decimal form. You are expected to show all your work.

1. Multiply unsigned numbers 10110111b (multiplicand) with 11101011b (multiplier) using the **Hard- ware Design 3**

<http://www.pitt.edu/~kmram/CoE0147/lectures/numbers3.pdf>

|  |  |  |  |
| --- | --- | --- | --- |
| 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.

*space for the work related to problem 2*

1. Convert the following 8-bit binary numbers into Booth’s encoding form:

01010011, 11010101, 01000001

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

36, -197, -56

1. Multiply signed numbers 10110111b (multiplicand) with 11101011b (multiplier) using the **Booth’s algorithm**

<http://www.pitt.edu/~kmram/CoE0147/lectures/numbers3.pdf>

|  |  |  |  |
| --- | --- | --- | --- |
| 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.

*space for the work related to problem 5*

1. Multiply signed numbers 01100001b (multiplicand) with 01011011b (multiplier) using the **Booth’s algorithm**

<http://www.pitt.edu/~kmram/CoE0147/lectures/numbers3.pdf>

|  |  |  |  |
| --- | --- | --- | --- |
| 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.

*space for the work related to problem 6*