Total Points: / 40 Name: Jeremiah Webb ID: 2545328

1. **(4 pts (2 pts each))** Write arithmetic right shift and logical right shift representation for the following binary:
   * 1. 1000 1111 Arithemtic: 1100 0111 Logical: 0100 0111
     2. 0111 0000 Arithmetic: 0011 1000 Logical: 0011 1000
2. **(12 pts (6 pts each))**Use the Booth algorithm to multiply
3. 23 (multiplicand) by -29 (multiplier),
4. -15 (multiplicand) by -19 (multiplier),

where each number is represented using 6 bits. Show all the steps in a tabular form.

Binary for Multiplier (M) = -29 = 011101

Twos Complement of M= 100011

Binary for multiplicand (Q)= 23 = 010111

Twos Complement of Q= 10 1001

|  |  |  |  |
| --- | --- | --- | --- |
| A | Q(23 ) | Q-1 | Operation |
| 000000 | 100011 | 0 | Initial Data |
| 010111 | 100011 | 0 | A = A - M |
| 001011 | 110001 | 1 | Shift Right |
| 000101 | 111000 | 1 | Shift Right |
| 101110 | 111000 | 1 | A = A + M |
| 110111 | 011100 | 0 | Shift Right |
| 111011 | 101110 | 0 | Shift Right |
| 111101 | 110111 | 0 | Shift Right |
| 010100 | 110111 | 0 | A = A - M |
| 001010 | 011011 | 1 | Shift Right |

Answer = -667 = 1010011011

Binary for Multiplier (M) = -15 = 001111

Twos Complement of M= 11 0001

Binary for multiplicand (Q)= -19 = 010011

Twos Complement of Q= 101101

|  |  |  |  |
| --- | --- | --- | --- |
| A | Q(-19) | Q-1 | Operation |
| 000000 | 101101 | 0 | Initial Data |
| 001111 | 101101 | 0 | A = A - M |
| 000111 | 110110 | 1 | Shift Right |
| 111000 | 110110 | 1 | A = A + M |
| 111100 | 011011 | 0 | Shift Right |
| 001011 | 011011 | 0 | A = A - M |
| 000101 | 101101 | 1 | Shift Right |
| 000010 | 110110 | 1 | Shift Right |
| 110011 | 110110 | 1 | A = A + M |
| 111001 | 111011 | 0 | Shift Right |
| 001000 | 111011 | 0 | A = A - M |
| 000100 | 011101 | 1 | Shift Right |

Answer = 285 = 100011101

1. **[20 pts]** Implement the Booths multiplier using Logisim. Submit the screenshot and the .circ file. It should be able to multiply two 4-bits numbers (remember result could be 8-bits)

