

Week 1: Binary Numbers and Operations

January 23-25, 2023

1. Consider a **5-bit** unsigned integer representation. Fill in the empty boxes in the following table. Addition and subtraction should be performed based on the rules for 5-bit, unsigned integer arithmetic.

Expression	Decimal Representation	Binary Representation
13	13	
21	21	
n/a		01010
n/a		10011
13 & 21		
13 && 21		
13 21		
13 21		
13 ^ 21		
~13		
!21		
13 << 1		
13 << 2		
21 >> 1		
21 >> 2		
13 + 21		
13 * 21		

2. In the following questions assume the variables a and b are unsigned 32-bit integers. Also assume that $UMAX$ is the maximum unsigned 32-bit integer, $UMIN$ is the minimum integer, and W is one less than the word length (i.e., $W = 31$, since we're dealing with 32-bit integers).

Match each of the descriptions on the left with a line of code on the right (write in the letter).

1. a

2. $\sim a$

3. $a \& b$

4. $a * 5$

5. $a / 4$

a. $\sim(\sim a \mid (b \wedge UMAX))$

b. $((a \wedge b) \& \sim b) \mid (\sim(a \wedge b) \& b)$

c. $1 + (a \ll 3) + \sim a$

d. $(a \ll 2) + a$

e. $a \wedge (UMIN + UMAX)$

f. $a \gg 2$

g. $(a \ll 4) + (a \ll 1)$