

## Problem Session 1: Binary Numbers and Operations

## SOLUTION

Wednesday, January 27, 2021

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	01101
21	21	10101
n/a	10	01010
n/a	19	10011
13 & 21	5	00101
13 && 21	1	00001
13   21	29	11101
13    21	1	00001
13 ^ 21	24	11000
~13	18	10010
!21	0	00000
13 << 1	26	11010
13 << 2	20	10100
21 >> 1	10	01010
21 >> 2	5	00101
13 + 21	2	00010
13 * 21	17	10001

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. $a$      | a. $\sim(\sim a \mid (b \wedge UMAX))$                     |
| $b$         | b. $((a \wedge b) \& \sim b) \mid (\sim(a \wedge b) \& b)$ |
| 2. $\sim a$ | c. $1 + (a \ll 3) + \sim a$                                |
| $e$         | d. $(a \ll 2) + a$   |
| 3. $a \& b$ | e. $a \wedge (UMIN + UMAX)$                                |
| $a$         | f. $a \gg 2$   |
| 4. $a * 5$  | g. $(a \ll 4) + (a \ll 1)$                                 |
| $d$         |  |
| 5. $a / 4$  |  |
| $f$         |  |