

## CS1800

Fall 2025

### Homework 2

**Assigned:** September 23, 2025

**Deadline:** September 30, 2025 at 9pm eastern

**Late Deadline:** October 2, 2025 at 9pm eastern

#### Submission Format

CS1800 Homeworks must be handwritten, on physical paper or a tablet. **Typed submissions will not be accepted.**

Submit a PDF or images to Gradescope. If you submit images, make sure they are JPEG, JPG, or PNG. (Don't submit iPhone HEIC images!) Each problem starts on a new page. Problem 1 is on a different page than Problem 2. Problems 1A and 1B can be on the same page.

#### Collaboration and Academic Integrity

We encourage you to work with classmates on these problems; list all collaborators on the first page of your submission. You may also consult outside sources, including generative AI; list all outside sources you referenced and how you used them on the first page of your submission.

However, **you must write all your solutions yourself, in your own words.** Do not submit anything you can't explain. Copying solutions from another person or an outside source is a violation of our academic integrity policy.

#### Deadline and Late Submissions

You can submit any/all homeworks up to 48 hours late with no penalty. However, **once the late deadline has passed, no submissions will be accepted.** This policy exists so you take extra time when you're especially busy, not feeling well, tending to your family, etc.; we won't make any exceptions to this policy.

Second-Chance Homework: You will have an opportunity at the end of the semester to submit one homework (HWs 1-6 only) for a new grade. If you miss both the deadline *and* the late deadline on a homework, use the Second-Chance to submit it.

#### For full credit

- select which pages go with which questions on Gradescope, and
- show ALL your work including intermediate steps.

**Your Name**

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**Your Collaborators (Classmates)**

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**Outside References and How You Used Them**

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**Problem #1 - Unsigned Numbers** ( $2+2+2+2 = 8$  points)

Convert each of the following (unsigned) numbers from its original base to the given base. For full credit, show all your work.

**1A**  $215_{10} = \underline{\hspace{2cm}}_2$

**1B**  $10110110111_2 = \underline{\hspace{2cm}}_{16}$

**1C**  $42011_5 = \underline{\hspace{2cm}}_{16}$

**1D**  $103_4 = \underline{\hspace{2cm}}_7$

**Problem #2 - Two's Complement** (3+3+2+2 = 10 points)

For this problem, assume we are in a 9-bit two's complement universe. Show all of your work, including the initial conversions of each number, and the steps and result of the arithmetic operation. (Recall that we don't actually perform the subtraction operation; we add negative values instead!)

- 2A** Convert both decimal numbers to 9-bit two's complement, perform the arithmetic indicated, and report the final answer. If overflow occurs, state it in your answer.

$$5_{10} - 228_{10}$$

Show your work and final answer here:

Overflow? \_\_\_\_\_

- 2B** Convert both decimal numbers to 9-bit two's complement, perform the arithmetic indicated, and report the final answer. If overflow occurs, state it in your answer.

$$- 138_{10} - 120_{10}$$

Show your work and final answer here:

Overflow? \_\_\_\_\_

- 2C** Would the following operation result in overflow in 9-bit two's complement?

$$011011110 + 001011011$$

Show your work and final answer here:

**2D** Would the following operation result in overflow in 9-bit two's complement?

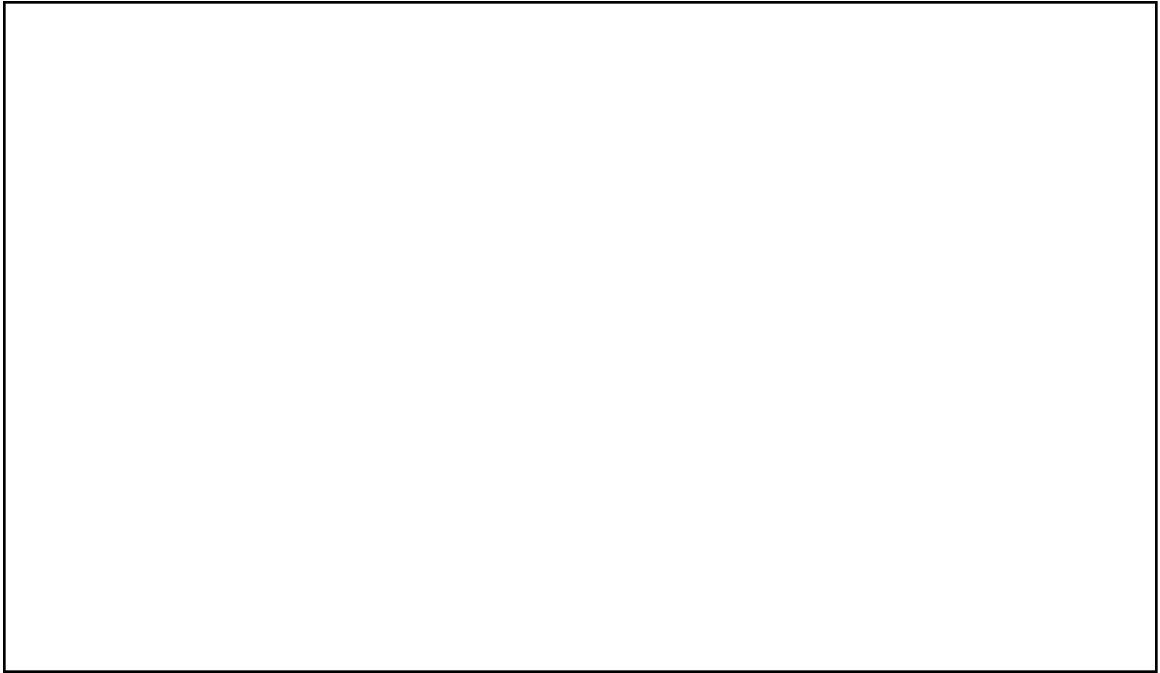
$$011001110 + 111100000$$

Show your work and final answer here:

**Problem #3 - Base Conversions** (3+3+3 = 9 points)

For each of the equations below, which all use unsigned numbers, determine the value of  $b$ , the base system being used. (All the  $b$  values in your solution will be positive values.)

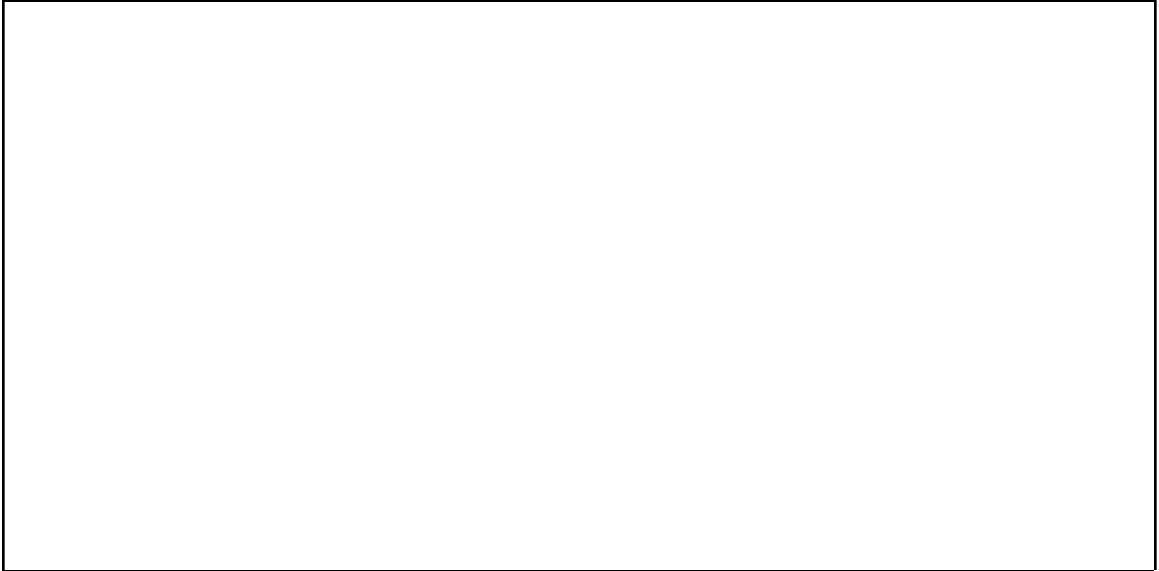
**3A**     $12_b + 1_b = 20_b$



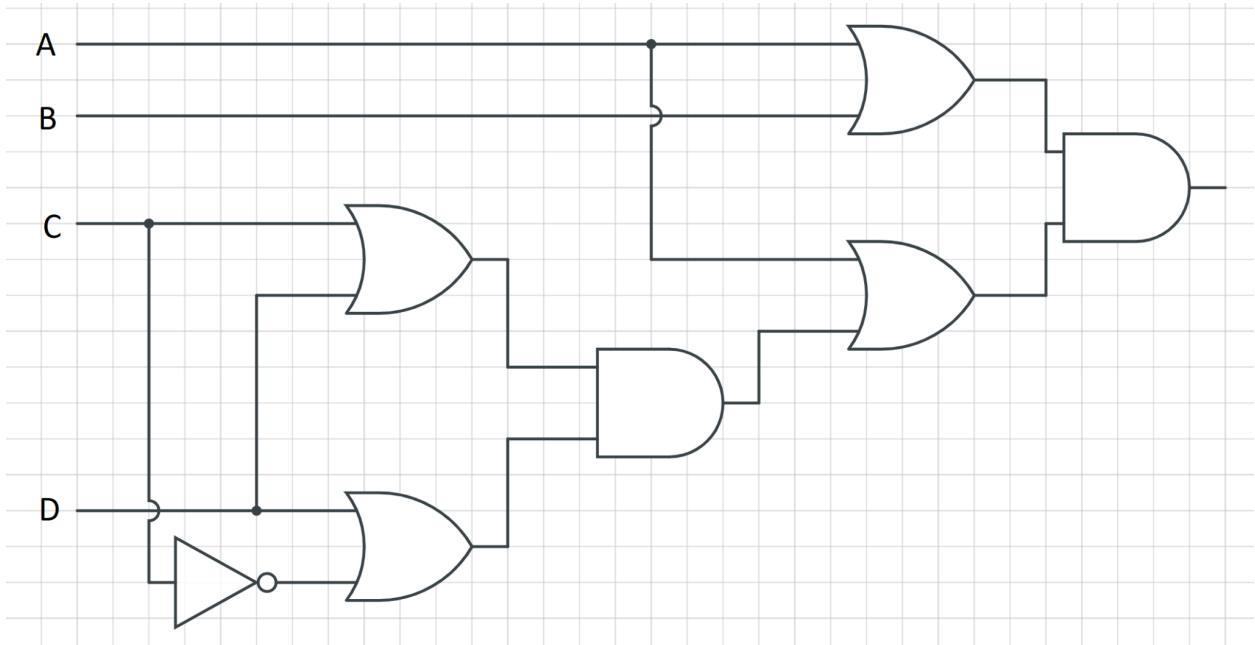
**3B**     $00111_{-2} + 101_b = 11101_{-2}$



3C  $611_b + 352_b = 1163_b$



**Problem #4 - Circuits & Logic** (3+4+3 = 10 points)



**4A** Write a logic statement that directly represents the circuit above.

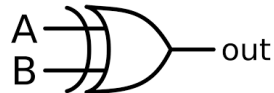
**4B** Use the laws of logical equivalence to simplify your expression from Part A so that it uses as few AND/OR/NOT gates as possible. As always, apply one law at a time, take small steps and label each one.

**4C** Draw a circuit that represents your simplified logic statement.

**Problem #5 - Circuit Operations** (2+3+3+3 = 11 points)

We've talked in class about how we can do everything we need in a computer by using just our and/or/not gates. For this problem, we'll work through how we do basic addition.

- 5A** Just like with logic, we sometimes work with shortcut gates, even though we can do everything with and/or/not. The gate equivalent for  $(A \wedge \neg B) \vee (\neg A \wedge B)$ , known in logic as XOR with the  $\oplus$  symbol, is drawn as:



Fill in the truth table for this gate.

A	B	$A \oplus B$
0	0	
0	1	
1	0	
1	1	

- 5B** Suppose we're adding just two unsigned bits. We have two inputs (A, B) and two outputs (sum, carry). The truth table looks like this:

A	B	Sum	Carry
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

Draw a circuit that implements this truth table.

**5C** Now suppose we need to go beyond two bits only and make a more complex circuit for addition. We'll now have three inputs: A, B, Carry-In (which is whatever we're bringing from a previous operation). And it will produce two outputs: Sum, Carry-Out.

Fill in the remainder of the truth table for this addition operation. (*Hint*: If you haven't yet completed this week's recitation, take a look at the relevant practice problem before tackling this!)

A	B	Carry In	Sum	Carry-Out
0	0			
0	0			
0	1			
0	1			
1	0			
1	0			
1	1			
1	1			

**5D** Draw a circuit that performs this addition operation (now we've done addition with logic!).