

**CPSC 2500**  
**Computer Organization**  
**Homework 5 (100 points)**  
**Due: Feb 26, 11:59 PM, on Canvas**

**NOTE:** Please code your answers to the following questions and submit it on Canvas by Oct 27. This assignment is to be done individually; you can discuss the questions with your classmates, but you should write your answers independently. This assignment would be **30% of the total assignments grade**.

**1. Multiplication (30 points)**

Write an ANNA assembly program (mul.ac) to multiply two positive numbers and print their product. Your program should take the numbers for multiplication from user input. If the user enters 10 and 20 as inputs, then the program should print 200 (the product).

**2. XNOR (30 points)**

In this question you will write an ANNA program to compute the XNOR of two numbers. The function XNOR is logical complement of XOR. The output of XNOR is one if and only if both the inputs are the same, otherwise it is zero. The truth table for XNOR is given below. Write an ANNA assembly program (xnor.ac) that asks the user for two numbers greater than zero and returns the bitwise exclusive-NOR (XNOR) of the numbers. For instance, if the user types in 64 (0000000001000000) and 100 (0000000001100100), the program should print -37 (111111111011011), the bitwise XNOR of the two numbers. Print -1 if the user entered a zero or less.

**Hint:** Consider using AND, OR, and NOT instructions for implementing the XNOR operation.

A	B	A XNOR B
0	0	1
0	1	0
1	0	0
1	1	1

### 3. The four largest numbers (40 points)

Write an ANNA assembly program (top\_four.ac) that finds the four largest numbers entered by the user. Initially, the program continually asks the user to enter numbers. As soon as a negative value is entered, compute which numbers are the top four (largest) numbers. For instance, if the user entered 2, 6, 7, 6, 6, 7, 6, 17, 15 -1; the program should print 17, 15, 7, 7 (the four largest numbers in the sequence). If the user enters a negative number at the beginning, print 0. If the user enters four or fewer numbers, print all the numbers as output.

Notes:

- The goal of this problem is to exercise storing, retrieving, and scanning the numbers stored in memory. Therefore a solution where you keep track of the max four numbers in registers as the numbers are entered is not acceptable. Such a solution will receive a maximum of 15 points for this problem.
- Do not keep track of everything in the input loop. You will need to store all numbers entered by the user in memory.
- Store all numbers entered into a growing array.
- The array should be the last item in your data section so it can grow as large as necessary.
- You may assume there is enough memory to hold all numbers entered by the user.

### Grading Requirements:

The assignment will be graded on functionality, though students are encouraged to follow recommended programming style as well. For information on proper style, refer to section 5 of the ANNA guide. Programs that fail to assemble will receive a zero.

Functionality will be based primarily on a suite of tests. A program that fails to successfully pass many of the tests will receive a very low score. Testing and debugging are important part of the programming process. Students who fail to test and debug their programs are handing in incomplete work and their grade will suffer as a result.

### Submitting your Program:

Programs will be submitted electronically on Canvas. Please follow the steps carefully:

1. Ensure the assembly code files have the proper names:

- Program 1: mul.ac
- Program 2: xnor.ac
- Program 3: top\_four.ac

2. Submit the three assembly files on Canvas. Please submit all three files in a single zip file.

- You may resubmit your assignment. If you do, please resubmit all three files (even if you changed only one). Only the last submission will be graded.
- Canvas will only accept .zip files.