

# TCSS371 – Machine Organization

## Assignment 1 – Data Representation

25 Points

**Group Member's Names:** \_\_\_\_\_

**Purpose:** This homework will test your understanding of the data representation concepts that we covered from Chapter 2 of your textbook.

**Student Learning Outcomes:** The following student-learning outcome is addressed in this assignment:

- convert numbers between various bases and use two's complement

1. (2s Complement Problems) Answer the following questions. Show your work as to how you got the answers. There are multiple parts in each question. Make sure to complete all of them.

- a. What is the largest positive number one can represent in 7-bit 2's complement code? Write your result in binary and decimal.
- b. What is the greatest magnitude negative number one can represent in a 7-bit 2's complement code? Write your result in binary and decimal.
- c. The following binary numbers are 5-bit 2's complement binary numbers. Which of the following operations generate overflow? Justify your answer by translating the operands and results into decimal.

- I.  $10111 + 00111$
- II.  $10101 - 00101$

d. Convert the following decimal numbers to hexadecimal representations of 2's complement numbers. You will have to convert the decimal numbers to 2's complement first before you convert to hexadecimal.

- I. 125
- II. -80

2. (Unsigned Representation Problems) Add the following **unsigned** binary numbers. Also, express the answer in decimal. You can use more than 5 bits to represent your answer, if needed.

- a.  $00101 + 11010$
- b.  $01010 + 01101$

3. (Java Programming) Write two Java methods to convert a 2's complement binary number to decimal and vice versa. You must write JUnit tests to test the corresponding code. Test for different size binary numbers and decimals. **DO NOT use any shortcuts or predefined methods other than Math class methods. You may NOT use any data structures and must use the basic array manipulation to perform the conversions.** The

method declarations to use are also provided below. You may create helper methods to remove any redundancy but the method signatures of those below cannot be changed.

```
// Takes an array of bits to return the corresponding
// decimal equivalent.
public static int convert2sCompToDecimal(char[] bits)

// Takes a decimal and returns the 2s complement equivalent.
// Assume that the decimal value won't require more than 16 bits.
public static char[] convertDecimalTo2sComp(int decimal)
```

Here's a sample JUnit test for one of the methods above.

```
@Test
public void testNegative2sComp() {
    char data[] = {'1', '0', '1', '0', '0'};
    assertEquals(-12, Convert.convert2sCompToDecimal(data));
}
```

You must write your code in **Convert.java** and tests in **ConvertTest.java**. **Good (Not excessive) comments** and explanations where necessary and a **program header** are a must.

- (Hexadecimal to binary, Hexadecimal to ASCII) Consider two hexadecimal numbers: x354E5A21 and x34243550. What values do they represent for each of the two data types shown?

	x354E5A21	X34243550
2's complement (in binary)		
ASCII string		

- (IEEE floating point to binary and vice versa)
  - Write the decimal equivalent of the following IEEE floating-point bit pattern.

110000001 011100000000000000000000

- Write IEEE floating point representation of the following decimal number.

10.5

**Group Submission guidelines:** Only one group member needs to submit the homework. Please make sure that the submission is made before the due date and time. Name your file, *datahw*.doc or docx or pdf, **Convert.java**, **ConvertTest.java**. You may scan your handwritten homework and upload as a **single** pdf document but it must be legible. You **must** show your work wherever it is applicable to get full credit. Points will be taken off for incorrect submissions that don't follow the guidelines above. Make sure to read the entire question and answer all parts of the question.

**Member Submission guidelines:** Each member in the group must submit their learning logs at the submission link. The format is below for your convenience. You may choose to have multiple of these in a single document for each homework.

**Start date:**

**Start time:**

**Resources used:**

**Struggles:**

**Wins:**

**Distractions:**

**End time:**

**Grading Criteria:** This assignment is worth 25 points and will be graded using the rubric below.

	Points
2s Complement Problems	5 Points total All the sub problems are solved correctly with the work shown Work not shown but answers are correct (1/2 the credit)
Unsigned Representation Problems	2.5 Points total All the sub problems are solved correctly with the work shown Work not shown but answers are correct (1/2 the credit)
Java Programming	5 Points total Both programs work and tests are correct Each method is 1 point each and each test is 1 point each. Documentation and program header is worth 1 point. Uses data structures or unnecessary methods

	(NO CREDIT)
Hexadecimal/ASCII	2.5 Points total
IEEE Floating point conversions	5 Points total Each conversion is correct and work is shown. Work not shown but answers are correct (1/2 the credit)
Learning Logs	5 Points Learning logs are complete with adequate information and contain group meeting information as well as individual attempts at the homework