

## Quiz #1

**Due: Wednesday September 6 – by 4:10 PM (Before Class)**

**Submission: Solve on paper submit results to Carmen**

Solve all questions on paper (or your choice of medium) first. Once you have your answers ready, start the corresponding Carmen quiz to enter your answers.

This quiz is individual work. You can consult class notes, use calculators and conversion tools, but you are not allowed to collaborate with other students.

### Question 1 – Range of **unsigned** 16-bit numbers (4 pts)

- (a) What is the **smallest** unsigned 16-bit number in **decimal**?
- (b) What is the **largest** unsigned 16-bit number in **decimal**?
- (c) What is the **smallest** unsigned 16-bit number in **hexadecimal**?  
Enter a hexadecimal number with four digits and the leading 0x, e.g., 0x12AB.
- (d) What is the **largest** unsigned 16-bit number in **hexadecimal**?  
Enter a hexadecimal number with four digits and the leading 0x, e.g., 0x12AB.

### Question 2 – Range of **signed** 16-bit numbers using two's complement (6 pts)

- (a) What is the **smallest** signed 16-bit number in **decimal**?
- (b) What is the **largest** signed 16-bit number in **decimal**?
- (c) What is the **smallest** signed 16-bit number in **hexadecimal**?  
Enter a hexadecimal number with four digits and the leading 0x, e.g., 0x12AB.
- (d) What is the **largest** signed 16-bit number in **hexadecimal**?  
Enter a hexadecimal number with four digits and the leading 0x, e.g., 0x12AB.

### Question 3 – Signed vs unsigned numbers (5 pts)

The content of a 16-bit register reads 0xB612.

- (a) What is the decimal value when interpreted as an **unsigned number**?
- (b) What is the decimal value when interpreted as a **signed number**?

**Question 4 – Negative numbers using two's complement (7 pts)**

How do you write the decimal value -107 as

(a) an **8-bit** signed number expressed in hexadecimal?

Enter a hexadecimal number with **two** digits and the leading 0x, e.g., 0x1A.

(b) a **16-bit** signed number expressed in hexadecimal?

Enter a hexadecimal number with **four** digits and the leading 0x, e.g., 0x12AB.

(c) a **32-bit** signed number expressed in hexadecimal?

Enter a hexadecimal number with **eight** digits and the leading 0x, e.g., 0x123456AB.

**Hint:** You do not need to work hard for parts (b) and (c).

**Question 5 – Overflow with signed and unsigned numbers (10 pts)**

Let  $A = (61)_{10}$  and  $B = (67)_{10}$ . Both numbers are stored in 8-bit registers, and are added using an 8-bit adder circuit. The output of the 8-bit adder is **an 8-bit sum** and a **carry bit** into the ninth bit position which is an indication of overflow in the unsigned range.

(a) What is the resulting 8-bit sum  $A+B$ ? Enter a binary number.

(b) What is the value of the sum as an 8-bit signed number? Enter a decimal number.

(c) Is the carry bit set with the operation described in part (a), i.e., is there unsigned number overflow?

(d) Is there **signed number overflow** with the operation described in part (a)?

**Question 6 – MCU Arithmetic (12 pts)**

MSP430FR6989 has instructions to add, subtract, and perform arithmetic bit-shifting (right and left), but no instructions to divide or multiply. Using this MCU you want to find the average value of the set of decimal numbers  $\{3, -37, 17, 11\}$ .

Assume 8-bit registers and two's complement notation for signed numbers.

First devise a scheme of how you can find the average of these numbers using 8-bit signed numbers and the given operations (pairwise addition, subtraction, and bit-shifting). Then answer following questions:

(a) What is the result in bits as it is stored in an 8-bit register? Enter a **binary** number.

(b) What is the corresponding value? Enter a **decimal** number.

**Make sure to double-check your results: confirm the format (binary, hex, decimal), count your bits, etc.**

**When you are ready start Quiz 1 on Carmen to enter your answers. You have only one attempt and 1 hour to enter all your results once you start the Carmen quiz.**