

Intro. to Computer Architecture
CSE 240 Autumn 2005**Homework 1**
Due: Fri. 16 September 2005

Write your answers on these pages. Additional pages may be attached (with staple) if necessary. Please ensure that your answers are legible. Please show your work. Write your name at the top of each page. Due at the *beginning of class*. Total points: 77.

1. [18 Points] **Basic Conversions.**

(a) Convert the binary number 01011000 to decimal.

(b) Convert the decimal number 55 to an 8-bit unsigned binary representation.

(c) Convert the 8-bit 2's complement binary number 10110010 to decimal.

(d) Convert the decimal number -123 to an 8-bit 2's complement binary representation.

(e) Convert the 8-bit unsigned binary number 10100110 to hexadecimal.

(f) Convert the unsigned hexadecimal number 4F37 to unsigned 8-bit binary.

2. [18 Points] **Binary Arithmetic and Logical Operations.** Let $A = 00011001$ and $B = 11010011$ be 2's complement integers. Compute the following, giving your answers in *both* 8-bit 2's complement and decimal. Assume a fixed width of 8 bits (*i.e.*, your answers must be 8 bits). Please show your work.

(a) $A + B$

(b) $A \text{ OR } B$

(c) $A \text{ AND } B$

(d) $B - A$

(e) $A - B$

(f) $A + \bar{B} + 1$

3. [14 Points] **Logical Operations.** Complete the following truth tables.

(a)

A	\bar{A}	$\bar{A} \text{ OR } 1$	$\bar{A} \text{ AND } 0$
0			
1			

(b)

A	B	C	$(A \text{ AND } B) \text{ OR } C$	$(A \text{ OR } C) \text{ AND } (B \text{ OR } C)$
0	0	0		
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1		

(c)

A	B	$(\bar{A} \text{ OR } \bar{B})$	$\overline{(A \text{ AND } B)}$
0	0		
0	1		
1	0		
1	1		

4. [8 Points] **Floating Point Conversions.**

- (a) Consider the 16-bit floating point number $A = 0100011000000000$, where the first bit represents the sign, the next 5 bits represent the exponent, and the last 10 bits represent the fraction (analogous to the floating point type defined in Figure 2.2 of the textbook). What is the value of this number in decimal? What is its value in binary? Note: Please choose the exponent offset (127 in Figure 2.2) to have an appropriate value given the distribution of bits in our 16-bit floating point representation.

- (b) Convert $A = 7\frac{3}{4}$ to a floating point in the above representation.

5. [9 Points] **Overflow.** Suppose $A = 11000$ is a 2's complement number.

(a) Give a 5-bit 2's complement number B such that $A + B$ overflows.

(b) Give the smallest 5-bit 2's complement number B such that $A + B$ does *not* overflow. Note that -1 is "smaller" than 0.

(c) Suppose A is sign-extended to 8 bits (note that it still holds the same value). What is the smallest 8-bit 2's complement number B such that $A + B$ does *not* overflow?

6. [10 Points] **The Meaning of Bits!** Consider the following sequence of 16 bits: 1000 0011 1110 0000. These bits can be interpreted in many different ways.

(a) If we interpret these bits as a 16-bit unsigned binary integer, what is the decimal value represented by the bit sequence?

(b) If we interpret these bits as a 16-bit 2's complement integer, what is the decimal value represented by the bit sequence?

(c) If we interpret these bits as a floating point number, what is the decimal value represented by the bit sequence? Assume that the floating point representation devotes 1 bit to the sign, 5 bits to the exponent, and 10 bits to the fraction (similar to Figure 2.2 in your textbook). Give the answer in the following form: $A \times 2^B$, where A and B are decimal numbers.

(d) Suppose that we again interpret these bits as a floating point number, but the representation now gives 8 bits to the exponent and 7 bits to the fraction. What is the decimal value (again, in scientific notation) represented by the bit sequence?

(e) If we interpret these bits as a Red-Green-Blue (RGB) color, what is the color represented by the bit sequence? Assume the high-order bit is always 1, the next 5 bits represent red, the next 5 bits represent green, and the low-order 5 bits represent blue.

[No Points] **Last and Most Important Question!** This question is compulsory. Give us your feedback.

(a) How many hours did you spend on this assignment?

(b) On a scale of 1-5, how difficult did you find this assignment? (1-easiest, 5-most difficult)

(c) Do you have any other comments on your experience completing this assignment? What are they?