

Name _____

ID# _____

Calculators or any other electronic devices are NOT allowed.

You must show steps to gain credits.

Problem 1 (3 points) If numbers are 8-bit wide including the sign and are in 2's complement form, what will be the smallest and largest possible numbers (write both binary and decimal representation for each).

Solution: The smallest number is $-2^{8-1} = -128$, whose binary form is 1000 0000. (1.5 pt)
 The largest number is $2^{8-1}-1 = 127$, whose binary form is 0111 1111. (1.5 pt)

Problem 2 (4 points) Stored in a big endian computer's memory (see figure below) is an IEEE 754 single precision floating point number A. Convert it into decimal form. (IEEE format is has 1 sign bit, 8 exponent bits and 23 fraction bits)

Solution: $A = 3F600000_{16}$ (1 pt)
 $= 0\ 011\ 1111\ 0\ 110\ 0000\ 0000\ 0000\ 0000\ 0000_2$.
 (1 pt)
 The exponent part is the biased one minus 127, which is $126 - 127 = -1$. (1 pt)
 Hence, the binary form of the number is $1.11_2 \times 2^{-1} = 0.111_2 = 0.5 + 0.25 + 0.125 = 0.875_{10}$.
 (1 pt)

Byte 3	00
Byte 2	00
Byte 1	60
Byte 0	3F

Problem 3 (3 points) Two 32-bit numbers in 2's complement form:
 $A = 1011\ 0001\ 0011\ 0101\ 0111\ 1001\ 1011\ 1101$,
 $B = 1000\ 1100\ 1000\ 1010\ 1000\ 0100\ 0110\ 0110$.
 First, find $A - B$ and state whether overflow/underflow occurs.

Solution: $-B$ is:
 $0111\ 0011\ 0111\ 0101\ 0111\ 1011\ 1001\ 1010$. (1 pt)
 Add it and A, and we get:
 $0111\ 0011\ 0111\ 0101\ 0111\ 1011\ 1001\ 1010$
 $+ 1011\ 0001\ 0011\ 0101\ 0111\ 1001\ 1011\ 1101$
 $1\ 0010\ 0100\ 1010\ 1010\ 1111\ 0101\ 0101\ 0111$

$A - B = 0010\ 0100\ 1010\ 1010\ 1111\ 0101\ 0101\ 0111$ (1 pt)

A and $-B$ have different signs, so there is neither overflow nor underflow, even though there is 1 carry bit (which we ignore). (1 pt).