COM219 HW3

Q1 (15 points) Quiz in class.

Q2 (18 points) Perform the following operations in binary. Also convert the given numbers and the results of the operations into their base-10 values and verify your calculations. Comment on whether the results are correct (i.e. whether they fit into the k-bit register with the given representation).

a) k=4, pure binary 1011 + 0011	**b)** k=6, pure binary 010100 + 011101	**c)** k=8, pure binary 11110001 - 01100011
d) k=6, two's complement 100011 - 110101 (perform two's comp. operation on 110101 and add)	**e)** k=6, two's complement 100011 + 101101	**f)** k=8, two's complement 00011101 + 00101010

Q3 (20 points) Complete the following table using the IEEE Floating Point Standard for single precision. <u>Show all calculations and reasoning</u>.

Value in base 10	Binary (IEEE-754 Floating Point)
?	**0 10000011 10100100000000000000000**
?	**1 10000111 01010100001000000000000**
-75.875	**?**
19.71875	**?**

Q4 (12 points) A 16-bit number representing $(-102)_{10}$, is written into memory in two's complement using little endian byte order.

a) Write the number in binary and show how it is stored in memory using 16-bit cells and 16-bit words.
b) Repeat (**a**) for 8-bit cells and 16-bit words.
c) Write the binary and find the value of the number (in base 10) if it is mistakenly read using a big endian byte order separately for parts (**a**) and (**b**).

Q5 (15 points) For each of the following memory systems assume there is only one memory chip per system. Note that the number of address lines on the address bus needed for the calculation of the CPU address space can be determined from the number of hex digits in the memory chip's address range in the second column (multiples of 4 for this question). Complete the table on your answer sheet. Show all calculations.

System	Address range of memory chip (hex)	Cell size (bits)	Size of CPU address space (locations)	Number of cells on memory chip	Percentage of chip size in address space	Capacity (bytes)
example	00H – 3FH	8 bits	256 locs	64 cells	$2^6/2^8 = 0.25$	64 bytes
A	200H – 3FFH	8 bits	?	?	?	?
B	0000H – ?	32 bits	?	2048 cells	?	?
C	80000H – ?	16 bits	?	?	?	512 KB (kilobytes)
D	? - ?	32 bits	?	?	1	256 KB
E	400000H – 6FFFFFH	64 bits	?	?	?	?

Q6 (20 points)

a) The following 4-symbol code is given. What is the distance of this code? How many bit errors can it correct? How many bit errors can it detect?

Symbol	Binary Codeword
α	001010000
β	111010111
μ	110010000
σ	000111111

b) The following 3-symbol code is given. What is the distance of this code? How many bit errors can it correct? How many bit errors can it detect?

Symbol	Binary Codeword
X	01001010101
Y	00100110011
Z	00000001111

c) We would like to design a code system to send two-digit hexadecimal numbers over a noisy transmission channel. In order to do this, we will encode the binary representation of each hexadecimal digit pair with a single Hamming Code. Find the number of message bits (m) and check bits (r) for this system. Find the Hamming Codes for B6H and 2FH that will be sent over the transmission channel. Use the convention presented in class (handout).

d) Repeat part (**c**) for four-digit hexadecimal numbers A3F8H and C0AEH in which each four-digit number is encoded with a single Hamming Code.

e) Assume the following two numbers have been received. Each has been encoded with a Hamming Code similar to part (**d**) but for 5 hex digits. Find the original numbers that were sent (in hex) – make sure you check for errors and correct them if present.
   i. 00101000110000011000011001
   ii. 01110100100010101101111100

f) In general, a long message consists of Hamming Code blocks sent back to back. Now assume that no two bits closer than 16 bits can be corrupted in this noisy transmission channel. Can the code systems given above work properly, i.e. perform the necessary error correction, over this transmission channel? Give your answer separately for parts (**c**), (**d**) and (**e**).