EE 231

Homework 1

1. Problem 1.1. Instead of Base 13, represent the numbers from 8 to 23 in base 14.

   16 to 32, octal and hexadecimal:

16_{10}	20_8	10_{16}
17_{10}	21_8	11_{16}
18_{10}	22_8	12_{16}
19_{10}	23_8	13_{16}
20_{10}	24_8	14_{16}
21_{10}	25_8	15_{16}
22_{10}	26_8	16_{16}
23_{10}	27_8	17_{16}
24_{10}	30_8	18_{16}
25_{10}	31_8	19_{16}
26_{10}	32_8	$1\mathrm{A}_{16}$
27_{10}	33_8	$1\mathrm{B}_{16}$
28_{10}	34_8	$1\mathrm{C}_{16}$
29_{10}	35_8	$1\mathrm{D}_{16}$
30_{10}	36_8	$1\mathrm{E}_{16}$
31_{10}	37_8	$1\mathrm{F}_{16}$
32_{10}	40_8	20_{16}

   8 to 30 in base 14:

8_{10}	8_{14}
9_{10}	9_{14}
10_{10}	A_{14}
11_{10}	B_{14}
12_{10}	C_{14}
13_{10}	D_{14}
14_{10}	10_{14}
15_{10}	11_{14}
16_{10}	12_{14}
17_{10}	13_{14}
18_{10}	14_{14}
19_{10}	15_{14}
20_{10}	16_{14}
21_{10}	17_{14}
22_{10}	18_{14}
23_{10}	19_{14}
24_{10}	$1\mathrm{A}_{14}$
25_{10}	$1\mathrm{B}_{14}$
26_{10}	$1\mathrm{C}_{14}$
27_{10}	$1\mathrm{D}_{14}$
28_{10}	20_{14}
29_{10}	21_{14}
30_{10}	22_{14}

2. What is the exact number of bytes of a system that contains (a) 16K bytes, (b) 24 M bytes, (c) 12.5 G bytes?

   (a) 16K = $16 \times 1024 = 16,384$

   (b) 24M = $24 \times 1024^2 = 25,165,824$

   (c) 12.5G = $12.5 \times 1024^3 = 13,421,772,800$

3. What is the largest binary number which can be expressed with 14 bits? What are the equivalent decimal and hexadecimal numbers?

   $11\ 1111\ 1111\ 1111_2 = 3FFF_{16} = 3 \times 16^3 + 15 \times 16^2 + 15 \times 16^1 + 15 \times 16^0 = 16,383_{10}$
   $11\ 1111\ 1111\ 1111_2 = 16,383_{10} = 37777_8 = 3FFF_{16}$

4. Convert the hexadecimal number 5A9C to binary, and then convert it to octal.

   $5A9C_{16} = 0101\ 1010\ 1001\ 1100_2 = 0\ 101\ 101\ 010\ 011\ 100_2 = 055234_8$

5. Convert the decimal number 391 to binary in two ways: (a) Convert directly to binary; (b) convert first to hexadecimal, then convert to binary.

   391/2 = 195 R 1 ↑
   195/2 = 97 R 1 ↑
   97/2 = 48 R 1 ↑
   48/2 = 24 R 0 ↑
   24/2 = 12 R 0 ↑
   12/2 = 6 R 0 ↑
   6/2 = 3 R 0 ↑
   3/2 = 1 R 1 ↑
   1/2 = 0 R 1 ↑

   $576_{10} = 1\ 1000\ 0111_2$

   391/16 = 24 R 7 ↑
   24/16 = 1 R 8 ↑
   1/16 = 0 R 1 ↑

   $391_{10} = 187_{16} = 1\ 1000\ 0111_2$

6. Express the following numbers in decimal:

   (a) $(11001.1011)_2 = 1 \times 2^4 + 1 \times 2^3 + 1 \times 2^0 + 1 \times 2^{-1} + 1 \times 2^{-3} + 1 \times 2^{-4} = 25.6875_{10}$

   (b) $(A3.C)_{16} = 10 \times 16^1 + 3 \times 16^0 + 12 \times 16^{-1} = 163.75_{10}$

   (c) $(75.16)_8 = 7 \times 8^1 + 5 \times 8^0 + 1 \times 8^{-1} + 6 \times 8^{-2} = 61.21875_{10}$

   (d) $(ABCD)_{16} = 10 \times 16^3 + 11 \times 16^2 + 12 \times 16 + 13 \times 16^0 = 43,981_{10}$

7. Convert the following binary numbers to hexadecimal and decimal:

   (a) $1.110101_2 = 1 \times 2^0 + 1 \times 2^{-1} + 1 \times 2^{-2} + 1 \times 2^{-4} + 1 \times 2^{-5} = 1.828125_{10}$

   $1.110101_2 = 1.D4_{16}$

   (b) $1110.101_2 = 1 \times 2^3 + 1 \times 2^2 + 1 \times 2^1 + 1 \times 2^{-1} + 1 \times 2^{-3} = 14.625_{10}$

   $1110.101_2 = E.A_{16}$

Explain why the decimal answer in (b) is 8 times that of (a).

(b) is just (a) with the decimal point shifted by 3 places to the left. In binary, shifting the decimal place one to the left is equivalent to multiplying by 2, so shifting 3 to the left is equivalent to mulitplying by 8.

8. Obtain the 1's and 2's complements of the following binary numbers:

	Number	1's Comp	2's Comp
(a)	10000000	01111111	10000000
(b)	00000000	11111111	00000000
(c)	10011011	01100100	01100101
(d)	01110110	10001001	10001010
(e)	00110011	11001100	11001101
(f)	11111111	00000000	00000001

9. (a) Find the 16's complement of $A7C5_{16}$.

   15's complement table:

0	F
1	E
2	D
3	C
4	B
5	A
6	9
7	8

   15's complement of $A7C5_{16}$ is $583A_{16}$. 16's complement is $583A_{16}+1 = 583B_{16}$.

   (b) Convert $A7C5_{16}$ to binary: $A7C5_{16} = 1010\ 0111\ 1100\ 0101_2$.

   (c) Find the 2's complment of the result in (b).
   1's complement is $0101\ 1000\ 0011\ 1010_2$. 2's complement is $0101\ 1000\ 0011\ 1010_2 + 1 = 0101\ 1000\ 0011\ 1011_2$.

   (d) Convert the answer in (c) to hexadecimal and compare it with the answer in (a)
   $0101\ 1000\ 0011\ 1011_2 = 583B_{16}$, same as for (a).

10. Do the following additions, where the numbers are 8 bits long:

    (1) 5F + 73 = D2

    (2) A3 + 46 = E9

    (3) C7 + 5A = 21 (Note: The addition gives 121_16, but we just keep the last eight bits.)

11. Do the following subtractions, where the numbers are 8 bits long:

    (1) 5F - 73 = D2

    (2) A3 - 46 = E9

    (3) A7 - 7A = 2D