

CS Basics - Exercises

Play with different bases

SOLUTIONS

E. Benoist

Fall Term 2018-19

1 Martian base

1.1 From Martian into decimal

Exercise 1 Convert the following martian numbers into decimal numbers.

- \equiv
 $equiv = 3$
- $\equiv f$
 $equiv, int = equiv * 4 + int = 3 * 4 + 1 = 13$
- $\equiv \theta$
 $equiv, theta = equiv * 4 + theta = 3 * 4 + 0 = 12$
- $\equiv f \theta$
 $equiv, int, theta = equiv * 4^2 + int * 4 + theta$
 $= 3 * 16 + 1 * 4 + 0 = 48 + 4 = 52$
- $\equiv f \theta \theta$
 $int, theta, theta = int * 4^2 + theta * 4 + theta = 16 + 0 + 0 = 16$
- $\equiv \theta \theta$
 $equiv, theta, theta = equiv * 16 + theta * 4 + theta = 3 * 16 + 0 + 0 = 48$
- $\equiv f \cap \cap \theta =$
 $int, cap, cap, theta = int * 4^3 + cap * 4^2 + cap * 4 + theta =$
 $1 * 64 + 2 * 16 + 8 + 0 = 64 + 32 + 8 = 104$
- $\equiv f f f \theta =$
 $int, int, int, int, theta = int * 4^4 + int * 4^3 + int * 4^2 + int * 4 + theta =$
 $1 * 256 + 1 * 64 + 1 * 16 + 4 + 0 = 256 + 64 + 16 + 4 = 340$

Exercise 2 Write the following decimal numbers in martian style:

- $4 = 1 * 4 + 0 = f \theta = int, theta$
- $5 = 1 * 4 + 1 = f j = int, int$
- $10 = 2 * 4 + 2 = \cap \cap = cap, cap =$
- $16 = 1 * 4^2 + 0 * 4 + 0 = f \theta \theta = int theta theta$
- $25 = 1 * 4^2 + 2 * 4 + 1 = f \cap j = int, cap, int$
- $154 = 2 * 64 + 1 * 16 + 2 * 4 + 2 = \cap j \cap \cap = cap, int, cap, cap$

2 Octal to decimal

Exercise 3 Convert the following octal numbers into decimal

- 100
 $1 * 8^2 = 64$
- 6573
 $3 * 8^0 + 7 * 8^1 + 5 * 8^2 + 6 * 8^3 =$
 $3 * 1 + 7 * 8 + 5 * 64 + 6 * 512 =$
 $3 + 56 + 320 + 3072 = 3451$
- 7777
 $7 * 8^0 + 7 * 8^1 + 7 * 8^2 + 7 * 8^3 =$
 $7 * 1 + 7 * 8 + 7 * 64 + 7 * 512 = 4095$
- 12345
 $5 * 8^0 + 4 * 8^1 + 3 * 8^2 + 2 * 8^3 + 1 * 8^4 =$
 $5 * 1 + 4 * 8 + 3 * 64 + 2 * 512 + 1 * 4096 = 5349$
- $100000=$
 $8^5 = 32768$

Exercise 4 Write the following decimal numbers into octal

- We use the following values:
 $8^2 = 64$
 $8^3 = 512$
 $8^4 = 4096$
 $8^5 = 32768$
 $8^6 = 262144$

- 20
 $20 = 2 \cdot 8 + 4$
Solution 24
- 350
 $350 = 5 \cdot 64 + 30$
 $30 = 3 \cdot 8 + 6$
Hence, $350 = 5 \cdot 64 + 3 \cdot 8 + 6$
Solution : 536
- 1000
 $1000 / 512 = 1; \text{ Rest} = 488$
 $488 / 64 = 7; \text{ Rest} = 40$
 $40 / 8 = 5; \text{ Rest} = 0$
 $0 / 1 = 0$
 $1000 = 1750_8$
- 890
 $890 / 512 = 1; \text{ Rest} = 378$
 $378 / 64 = 5; \text{ Rest} = 58$
 $58 / 8 = 7; \text{ Rest} = 2$
 $2 / 1 = 2$
 $890 = 1572_8$

3 Hexadecimal to decimal

Exercise 5 *Compute the decimal values for the following Hexadecimal numbers
 We use the letter H to denote the hexadecimal numbers (consequently with the slides).
 For the solution we first need to have the powers of 16:*

- $1 = 1H$
- $16 = 10H$
- $256 = 16^2 = 100H$
- $4096 = 16^3 = 1000H$
- $65'536 = 16^4 = 10000H$
- $1'048'536 = 16^5 = 100000H$

Let us use those data to compute the values

- $99H = 9 \cdot 16 + 9 = 153$
- $A5CH = 10 \cdot 256 + 5 \cdot 16 + 12 = 2652$

- $700H = 7 \cdot 256 = 1792$
- $E03H = 14 \cdot 256 + 3 = 3587$
- $BBF9H = 11 \cdot 4096 + 11 \cdot 256 + 15 \cdot 16 + 9 = 48'121$
- $C9H = 12 \cdot 16 + 9 = 201$

Exercise 6 • $FFFFH = 65'536 - 1 = 65'535$

- $1000H = 4096$
- $1119H = 4096 + 256 + 16 + 9 = 4377$
- $2345H = 9029$
- $739AEH = 7 \cdot 65536 + 3 \cdot 4096 + 9 \cdot 256 + 10 \cdot 16 + 14 \cdot 1 = 473'518$

One can also compute:

$$739AEH = (((7 \times 16 + 3) \times 16 + 9) \times 16 + 10) \times 16 + 14 = 473'518$$

Exercise 7 • $FFH = 100H - 1 = 255$

- $CA45CH = 12 \cdot 65536 + 10 \cdot 4096 + 4 \cdot 256 + 5 \cdot 16 + 12 \cdot 1 = 828'508$
- $C8900H = 12 \cdot 65536 + 8 \cdot 4096 + 9 \cdot 256 = 821'504$
- $CCH = 12 \cdot 16 + 12 = 204$
- $8B359002H = 2335543298$

4 Decimal to Hexadecimal

Exercise 8 Write the following decimal numbers into hexadecimal

- $304 = 130H$
 $304 / 16$ is 19, rest 0
 $19 / 16$ is 1, rest 3
 $1 / 16$ is 0, rest 1
- $4095 = 4096 - 1 = 1000H - 1 = FFFH$
- $31'155 = 79B3H$
 $31155 / 16$ is 1947, rest is 3
 $1947 / 16$ is 121, rest is 11 = B
 $121 / 16$ is 7, rest is 9
 $7 / 16$ is 0, rest is 7
- $1011001 = F6D39H$
- $12345678 = BC614EH$

5 Binary

Exercise 9 Convert into decimal the following binary values

To solve the following exercises, we use the following table of powers of 2

1B	2^0	1
10B	2^1	2
100B	2^2	4
1000B	2^3	8
10000B	2^4	16
100000B	2^5	32
1000000B	2^6	64
10000000B	2^7	128
100000000B	2^8	256
1000000000B	2^9	512
10000000000B	2^{10}	1024
100000000000B	2^{11}	2058

- $101B=5$
- $1100B=4+8=12$
- $1000111B=1+2+4+64=71$
- $101010101B=1+4+16+64+256=341$
- $11011011B=1+2+8+16+64+128=219$
- $10001B=1+16=17$

Exercise 10 Convert into binary the following numbers

- $5=4+1=0101B$
- $10=8+2=1010B$
- $25=16+8+1=11001B$
- $1000=512+256+64+32+8=1111101000B$
- $245=128+64+32+16+4+1=11110101B$

6 Hexadecimal to binary (and vice versa)

Exercise 11 Write in binary the following hex numbers

- $0AH = 0000\ 1010\ B$
- $10H = 0001\ 0000\ B$

- $04H = 0000\ 0100\ B$
- $AAH = 1010\ 1010\ B$
- $A0H = 1010\ 0000\ B$
- $40H = 0100\ 0000\ B$
- $573CDH$

573CDH =
 0101 0111 0011 1100 1101 B
 5 7 3 C D H

- $CFF32H$

CFF32H =
 1100 1111 1111 0011 0010 B
 C F F 3 2 H

- $40AA001100AH =$

0100 0000 1010 1010 0000 0000 0001 0001 0000 0000 1010B
 4 0 A A 0 0 1 1 0 0 A H

- $40AA001100A40AA001100AH$

0100 0000 1010 1010 0000 0000 0001 0001 0000 0000
 1010 0100 0000 1010 1010 0000 0000 0001 0001 0000 0000 1010B
 4 0 A A 0 0 1 1 0 0
 A 4 0 A A 0 0 1 1 0 0 A

Exercise 12 Write in hex the following binary numbers

- $1000B=8H$
- $1111B=FH$
- $1001B=9H$
- $0001B=1H$
- $0011B=3H$
- $10100011B=A3H$
- $01110111B=77H$
- $11010111B=D7H$

7 Operations using Hex numbers

Exercise 13 Add the following numbers

- $A23H + 5BBH = FDEH$
- $DE56F3H + 78FFEh = E5E6F1H$
- $AAAAAAH + 1234567H = BCDF011H$
- $FEAH + 123AH = 2224H$
- $A00AH + FFAH = 1A004H$

Exercise 14 Execute the following subtractions

- $ABCDEF00H - 12345678H = 9999992H$
- $BAD343H - BACCAAH = 000699H$
- $123456H - AAAAAH = 0789ACH$
- $12F36AEH - 0AAAAFH = 1248BFFH$

8 Switch binary flags

Exercise 15 In programming, we will sometime just switch a binary flag, i.e. add a binary number to an hex number

- $AAH + 000100000010000B = AAH + 1010H = 10BAH$
- $10H + 001000000000001B = 10H + 2001H = 2011H$
- $34H + 000100000000000B = 34H + 1000H = 1034H$
- $ECH + 000000000000000B = ECH + 0 = ECH$
- $A9H + 010000000010000B = A9H + 4010H = 40B9H$
- $A0H + 0000000100010000B = A0H + 0110H = 01B0H$