Computer Architecture and Programming Languages
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Homework 1

Problem 1.1

Solution:

a) 10100 (base 2) $= 1*2^4+0*2^3+1*2^2+0*2^1+0*2^0 = 16+4 = 20$ base (10)

b) 11011011 (base 2) $= 1*2^7+1*2^6+0*2^5+1*2^4+1*2^3+0*2^2+1*2^1+0*2^0 = 128+64+16+8+2+1 = 219$ (base 10)

c) 001001001 (base 2) $= 1*2^6+0*2^5+0*2^4+1*2^3+0*2^2+0*2^1+1*2^0 = 64+8+1 = 73$ (base 10)

d) 111111111111 (base 2) $= 1*2^11+1*2^10+1*2^9+1*2^8+1*2^7+1*2^6+1*2^5+1*2^4+1*2^3+1*2^2+1*2^1+1*2^0 = 2048+1024+512+256+128+64+32+16+8+4+2+1 = 4095$ (base 10)

e) 75077 (base 8) $= 7*8^4+5*8^3+0*8^2+7*8^1+7*8^0 = 28672+2560+56+7 = 31295$ (base 10)

f) 12101 (base 3) $= 1*3^4+2*3^3+1*3^2+0*3^1+1*3^0 = 81+54+9+1 = 145$ (base 10)

g) 26601 (base 7) $= 2*7^4+6*7^3+6*7^2+0*7^1+1*7^0 = 4802+2058+294+1 = 7155$ (base 10)

h) 431021 (base 5) $= 4*5^5+3*5^4+1*5^3+0*5^2+2*5^1+1*5^0 = 12500+1875+125+10+1 = 14511$ (base 10)

Problem 1.2

Solution:

a) 4272 (base 10) To convert we should be dividing it by 2 until it is equal to 0, while taking note of reminders.
$4272/2 = 2136$ (0)
$2136/2 = 1068$ (0)
$1068/2 = 534$ (0)
$534/2 = 267$ (0)
$267/2 = 133$ (1)
$133/2 = 66$ (1)
$66/2 = 33$ (0)
$33/2 = 16$ (1)
$16/2 = 8$ (0)
$8/2 = 4$ (0)
$4/2 = 2$ (0)
$2/2 = 1$ (0)
$1/2 = 0$ (1)
Taking the sequence of reminders from bottom to up gives us 1000010110000 (base 2)

b) CBA (base 16) To convert it, we should be converting decimal representations of digits to their binary equivalent reserving 4 bits for every digit.
$CBA = 121110 = 110010111010 = 110010111010$ (base 2)

c) $B8C$ (base 16)$= B*16^2+8*16^1+C*16^0 = 11*16^2+8*16^1+12*16^0 = 2816+128+12 = 2956$ (base 10)

d) $29D8$ (base 16)$= 2*16^3+9*16^2+D*16^1+8*16^0 = 2*16^3+9*16^2+13*16^1+8*16^0 = 8192+2304+208+8 = 10712$ (base 10)

e) $8CE$ (base 16) The next 5 numbers, to find them let's increment $8CE$ 5 times.
$8CE+1 = 8CF$
$8CF+1 = 8D0$
$8D0+1 = 8D1$
$8D1+1 = 8D2$
$8D2+1 = 8D3$

Problem 1.3

Solution:

a) 732 (base 10) We need to convert every digit individually reserving 4 bits for each of them.
$7 = 0111$
$3 = 0011$
$2 = 0010$
$732 = 011100110010$ (BCD)

b) Due to the fact that we are allowed to use only decimal numbers for direct conversion to BCD, that restricts us to convert only digits, so only 0-9 will be used. However, using 4 bits we can represent numbers in the range 0-15. Therefore, everything 10-15 is invalid BCD code:
$10 = 1010$
$11 = 1011$
$12 = 1100$
$13 = 1101$
$14 = 1110$
$15 = 1111$

c) 100101010110 (BCD)
$1001 = 9$
$0101 = 5$
$0110 = 6$
$100101010110 = 956$ (base 10)

d) To answer this question we just need to convert 77 which is decimal to binary and hexadecimal.
To binary:
$77/2 = 38$ (1)
$38/2 = 19$ (0)
$19/2 = 9$ (1)
$9/2 = 4$ (1)
$4/2 = 2$ (0)
$2/2 = 1$ (0)
$1/2 = 0$ (1)
Therefore, the number is 1001101 (base 2).
To hex:
$77/16 = 4$ (13)
$4/16 = 0$ (4)
$77 = 413$ (base 16) $= 4D$ (base 16)

e) Convert 109:
$109/2 = 54$ (1)
$54/2 = 27$ (0)
$27/2 = 13$ (1)
$13/2 = 6$ (1)
$6/2 = 3$ (0)
$3/2 = 1$ (1)
$1/2 = 0$ (1)
The number is 1101101 (base 2).

To hex:
$109/16 = 6$ (13)
$6/16 = 0$ (6)
$109 = 613 = 6D$ (base 16)

Problem 1.4

Solution:

OR:

A	B	A OR B
0	0	0
0	1	1
1	0	1
1	1	1

AND:

A	B	A AND B
0	0	0
0	1	0
1	0	0
1	1	1

NOT:

A	NOT B
0	1
1	0

a) OR has high output for one low output in case when at least one of the inputs is high. Doesn't satisfy the condition.

NOT has high output in case of low input. Also doesn't satisfy.

AND requires all high input to give high output. That satisfes the equation, so that is the answer.

b) **OR** has low output only when all inputs are zeros. Satisfies the condition. This is the answer.

NOT has high output in case of low input. Doesn't satisfy.

AND requires all high input to give high output.Meaning that some inputs may be high, and output would be still low. Doesn't satisfy the condition.

Problem 1.5

Solution:

A	B	C	A AND B AND C
0	0	0	0
1	0	0	0
0	1	0	0
0	0	1	0
1	1	0	0
1	0	1	0
0	1	1	0
1	1	1	1

Problem 1.6

Solution:

A	B	C	D	A OR B OR C OR D
0	0	0	0	0
1	0	0	0	1
0	1	0	0	1
0	0	1	0	1
0	0	0	1	1
1	1	0	0	1
1	0	1	0	1
1	0	0	1	1
0	1	1	0	1
0	1	0	1	1
0	0	1	1	1
1	1	1	0	1
1	1	0	1	1
1	0	1	1	1
0	1	1	1	1
1	1	1	1	1