Problem Set 09: Number Systems

CSCI 540: Computer Architecture Spring 2021

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Name: Chiho Kim

1. Perform the indicated base conversions:

a. 54_8 to base 5

$54_8 = 5 * 8^1 + 4 * 8^0$

$= 40 + 4 = 44_{10}$

$= 8 * 5^1 + 4 * 5^0$

$= 84_5$

b. 312_4 to base 7

$312_4 = 3 * 4^2 + 1 * 4^1 + 2 * 4^0$

$= 48 + 4 + 2$

$= 54_{10}$

$= 1 * 7^2 + 5 * 7^0$

$= 15_7$

c. 520_6 to base 7

$520_6 = 5 * 6^2 + 2 * 6^1$

$= 180 + 12$

$= 192_{10}$

$= 3 * 7^2 + 6 * 7^1 + 3 * 7^0$

$= 363_7$

d. 12213_3 to base 9

$12213_3 = 1 * 3^4 + 2 * 3^3 + 2 * 3^2 + 1 * 3^1 + 3 * 3^0$

$= 81 + 54 + 18 + 3 + 3$

$= 159_{10}$

$= 1 * 9^2 + 8 * 9^1 + 6 * 9^0$

$= 186_9$

2. Convert the following binary numbers to their decimal equivalents:

a. 001100

$001100 = 2^3 + 2^2 = 12_{10}$

b. 000011

$000011 = 2^1 + 2^0 = 3_{10}$

c. 011100
$011100 = 2^4 + 2^3 + 2^2 = 16 + 8 + 4 = 28_{10}$
d. 11100 $11100 = 2^4 + 2^3 + 2^2 = 28_{10}$ e. 101010
$101010 = 2^5 + 2^3 + 2^1 = 32 + 8 + 2 = 42_{10}$

3. Convert the following binary numbers to their decimal equivalents:

a. 111100.011
$111100.011 = 2^5 + 2^4 + 2^3 + 2^2 + 2^-2 + 2^-3$
$= 32 + 16 + 8 + 4 + \frac{1}{4} + \frac{1}{8}$
$= 60 + 0.25 + 0.125 = 60.375_{10}$
b. 110011.10011
$110011.10011 = 2^5 + 2^4 + 2^1 + 2^0 + 2^-1 + 2^-4 + 2^-5$
$= 32 + 16 + 2 + 1 + \frac{1}{2} + \frac{1}{16} + \frac{1}{32}$
$= 51 + 0.5 + 0.0625 + 0.03125 = 51.59375_2$
c. 1010101010.1
$1010101010.1 = 2^9 + 2^7 + 2^5 + 2^3 + 2^1 + 2^-1$
$= 512 + 128 + 32 + 8 + 2 + 0.5$
$= 682.5_{10}$

4. Convert the following decimal numbers to their binary equivalents:

a. 64
$64 = 1 * 2^6 + 0 * 2^5 + \ldots + 0 * 2^0$
$= 1000000_2$
b. 100
$100 = 64 + 32 + 4$
$= 1 * 2^6 + 1 * 2^5 + 1 * 2^2$
$= 1100100_2$
c. 111
$111/2 = 55 + 1/2$
$55/2 = 27 + 1/2$
$27/2 = 13 + 1/2$
$13/2 = 6 + 1/2$ $6/2 = 3$
$3/2 = 1 + 1/2$ $111 = 55 * 2 + 1 = 27 * 2^2 + 2 + 1$
$= 13 * 2^3 + 2^2 + 2^1 + 2^0$
$= 6 * 2^4 + 2^3 + 2^2 + 2^1 + 2^0$
$= 3 * 2^5 + 2^3 + 2^2 + 2^1 + 2^0$
$= 1 * 2^6 + 2^5 + 2^3 + 2^2 + 2^1 + 2^0$
$= 1101111_2$
d. 145

$145 = 128 + (145 - 128) = 128 + 17 = 128 + 16 + 1$
$= 2^7 + 2^4 + 2^0$
$= 10010001_2$
e. 255
$255 = 256 - 1 = 2^8 - 1 = 2^7 + 2^6 + \ldots + 2^0$
$= 11111111_2$

5. Convert the following decimal numbers to their binary equivalents:

a. 34.75
$= 32 + 2 + 0.5 + 0.25$
$= 2^5 + 2^{-1} + 2^{-2}$
$= 100000.11_2$
b. 25.25
$= 16 + 8 + 1 + \frac{1}{4}$
$= 2^4 + 2^3 + 2^0 + 2^{-2}$
$= 11001.01_2$
c. 27.1875
$= 16 + 8 + 2 + 1 + 0.125 + 0.0625 = 2^4 + 2^3 + 2^1 + 2^0 + 2^{-3} + 2^{-4}$
$= 11011.0011_2$

6. Convert the following hexadecimal numbers to their decimal equivalents:

a. C
$= A + 2 = 12_{10}$ b. 9F
$9 * 16^1 + F * 16^0$
$= 144 + 15$
$= 159_{10}$
c. D52
$(A + 3) * 16^2 + 5 * 16^1 + 2 * 16^0$
$= 13 * 16 * 16 + 5 * 16 + 2$
$= 3328 + 80 + 2$
$= 3410_{10}$
d. 67E
$6 * 16^2 + 7 * 16^1 + (A + 4) * 16^0$
$= 1662_{10}$ e. ABCD
$10 * 16^3 + 11 * 16^2 + 12 * 16^1 + 13 * 16^0$
$= 43981_{10}$

7. Convert the following hexadecimal numbers to their decimal equivalents:

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a. F.4

$= 15 * 16^0 + 4 * 16^{-1}$

$= 15 + 0.0625$

$= 15.0625_{10}$

b. D3.E

$= 13 * 16^1 + 3 * 16^0 + 14 * 16^{-1}$

$= 211.875_{10}$

c. 1111.1

$= 16^3 + 16^2 + 16^1 + 16^0 + 16^{-1}$

$= 4369 + 0.0625$

$= 4369.0625_{10}$

d. 888.8

$= 8 * 16^2 + 8 * 16^1 + 8 * 16^0 + 8 * 16^{-1}$

$= 2134.5_{10}$

e. EBA.C

$= 15 * 16^2 + 11 * 16^1 + 10 * 16^0 + 12 * 16^{-1}$

$= 3770 + 0.75 = 3770.75_{10}$

8. Convert the following decimal numbers to their hexadecimal equivalents:

a. 16

$= 16^1 = 0x10$

b. 80

$= 5 * 16^1 = 0x50$

c. 2560

$= 256 * 10 = 10 * 16^2 = 0xA00$

d. 3000

$= 3000 = 16 * 187 + 16 * 0.5$

$= 16 * (16 * 11 + 16 * 0.6875) + 16 * 0.5$

$= 11 * 16^2 + 16^2 * 0.6875 + 16 * 0.5$

$= 11 * 16^2 + 11 * 16^1 + 8 * 16^0$

$= 0xBB8$

e. 62500

$62500 = 16 * 3906.25$

$= 16 * (16 * 244.125 + 0.25)$

$= 16 * (16 * (16 * 15.25 + 0.125) + 0.25)$

$= 16 * (16 * (16 * 15 + 16 * 0.25 + 0.125) + 0.25) = 15 * 16^3 + 4 * 16^2 + 2 * 16^1 + 4 * 16^0$

$= 0xF424$

9. Convert the following decimal numbers to their hexadecimal equivalents:

a. 204.125

$204 = 12 * 16$

$0.125 = 2 * 16^{-1}$

$204.125 = 0xC.2$

b. 255.875

$255 = 16^2 - 1 = 15 * 16^1 + 15 * 16^0$

$0.875 = 14 * 16^{-1}$ $255.875 = 0xFF.D$

c. 631.25

$631 = 16 * 39 + 16 * 0.4375 = 16(16 * 2 + 7) + 7 = 2 * 16^2 + 7 * 16^1 + 7 = 0.25 = 4 * 16^{-1}$

$631.25 = 0x277.4$

d. 10000.00390625

$10000 = 16 * 625 = 16 * (16 * 39 + 1) = 16 * (16 * (16 * 2 + 7) + 1)$

$= 2 * 16^3 + 7 * 16^2 + 1 * 16^1$

$0.00390625 = 0.0625 * 16^{-1} = 16^{-2}$

$10000.00390625 = 2710.01

10. Convert the following hexademical numbers to their binary equivalents:

a. E

$E = F - 1 = 1110_2$

b. 1C

$1 = 0001, C = 12_{10} = 8 + 4 = 1100$

$1C = 0001\ 1100_2$

c. A64

$A = 10_{10} = 8 + 2 = 1010$

$6 = 4 + 2 = 0110$

$4 = 0100$

$A64 = 1010\ 0110\ 0100_2$

d. 1F.C $1F = 0001\ 1111_2$

$0.C = 12 * 16^{-1} = 0.75 = 0.5 + 0.25$

$= \frac{1}{2} + \frac{1}{4}$

$= 0.11$

$0001\ 1111\ 1100_2$

e. 239.4

$239 = 0010\ 0011\ 1001$

$0.4 = 0.0100$ $239.4 = 0010\ 0011\ 1001\ 0100_2$

11. Convert the following binary numbers to their hexadecimal equivalents:

a. 1001.1111

$1001 = 8 + 1 = 9, 1111 = F$

$1001.1111 = 9.F$

b. 110101.0111001

$= 0011\ 0101.0111\ 0011$

$= 0x35.73$

c. 10100111.111011

$= 1010\ 0111.1110\ 1100$

$= 0xA7.EC$

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