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1.
.

a. 11001100_2
$= 2^7(1) + 2^6(1) + 2^5(0) + 2^4(0) + 2^3(1) + 2^2(1) + 2^1(0) + 2^0(0)$
$= 204_{10}$

b. 11001100_3
$= 3^7(1) + 3^6(1) + 3^5(0) + 3^4(0) + 3^3(1) + 3^2(1) + 3^1(0) + 3^0(0)$
$= 2\ 952_{10}$

c. 11001100_4
$= 4^7(1) + 4^6(1) + 4^5(0) + 4^4(0) + 4^3(1) + 4^2(1) + 4^1(0) + 4^0(0)$
$= 20\ 560_{10}$

2. .

a. 10 000_{10} in binary

- = 10 000 / 2 = 5000 R: 0
- = 5000 / 2 = 2500 R: 0
- = 2500 /2 = 1250 R: 0
- = 1250 / 2 = 625 R: 0
- = 625 / 2 = 312 R: 1
- = 312 /2 = 156 R: 0
- = 156/2 = 78 R: 0
- = 78 /2 = 39 R: 0
- = 39/2 = 19 R: 1
- = 19/2 = 9 R: 1
- = 9/2 = 4 R: 1
- = 4 /2 = 2 R: 0
- = 2 /2 = 1 R: 0
- = 1 /2 = 0 R: 1
- = 10 0111 0001 0000

b. .

- FEDC.BA
- = 1111 1110 1011 1010. 1011 1010
- = 1 111 111 010 111 010. 101 110 100
- = 177272.564

c. .

- 12345.67
- 001 010 011 100 101 . 110 111
- 0001 0100 1110 0101 . 1101 1100
- 14E6.DC

3. .

a. $25_r = 23_{10}$
   - $r^1(2) + r^0(5) = 23$
   - $2r + 5 = 23$
   - $2r = 18$
   - $r = 9$

b. $1001_s = 19684_{10}$
   - $s^3(1) + s^2(0) + s^1(0) + s^0(1) = 19684$
   - $s^3 + 1 = 19684$
   - $s^3 = 19683$
   - $s = 27$

c. $1001_t = 4931_{10}$
   - $t^3(1) + t^2(0) + t^1(1) + t^0(1) = 4931$
   - $t^3 + t + 1 = 4931$
   - $t(t^2 + 1) = 4930$
   - $(t-17)(t^2 + 17t + 290) = 0$
   - $t = 17$ (other roots imaginary)

4. .

a. -9876_{10}

- 9876/2 = 4938 R:0
- 4938/2 = 2469 R:0
- 2469/2 = 1234 R:1
- 1234/2 = 617 R:0
- 617/2 = 308 R:1
- 308/2 = 154 R:0
- 154/2 = 77 R:0
- 77/2 = 38 R:1
- 38/2 = 19 R:0
- 19/2 = 9 R:1
- 9/2 = 4 R:1
- 4/2 = 2 R:0
- 2/2 = 1 R:0
- 1/2 = 0 R:1
- 10 0110 1001 0100(unsigned)
- 110 0110 1001 0100(signed)
- 001 1001 0110 1100 (2's complement)

b. -98.76543_{10}

- 98/2 = 49 R:0
- 49/2 = 24 R:1
- 24/3 = 12 R:0
- 12/2 = 6 R:0
- 6/2 = 3 R:0
- 3/2 = 1 R:1
- 1/2 = 0 R:1
- 110 0010
- .76543 x 2 = 0.53986 WP: 1
- 0.53086 x 2 = 0.06172 WP: 1
- 0.06172 x 2 = 0.12344 WP:0
- 0.12344 x 2 = 0.24688 WP:0
- 0.24688 x 2 = 0.49376 WP:0
- 0.49376 x 2 = 0.98752 WP:0
- 0.98752 x 2 = 0.97502 WP:1
- 0.97502 x 2 = 0.95008 WP:1
- 0.95008 x 2 = 0.90016 WP:1
- 0.90016 x 2 = 0.80032 WP:1
- .1100 0011 11
- 0110 0010.1100 0011 1100
- 1001 1101.0011 1100 0100

5. .

a. 1010.101
   - 10 + 1/2 + 1/3
   - 10.625

b. 1010.101 = -10.101 = +
   - -2.625

c. 0101.010 + = 0110.0110
   - -5.375

6. .

a. 1010 1010 + 1111 1111
   - 1010 1010 + 0000 0001(2’s complement)
   - = 1 1010 1001(with overflow)
   - = 1010 1001 (ignore overflow)

b. 0101 1111 + 0111 0101
   - = 1101 0100
   - overflow!because the sign of the sums don’t match

c. 1111 0101 + 0101 0101
   - 0100 1010
   - no overflow because carry in = carry out

7. .

a. -1234.875_{10}
   - -1234
   - 1234/2 = 617 R:0
   - 617/2 = 308 R:1
   - 308/2 = 154 R:0
   - 154/2 = 77 R:0
   - 77/2 = 38 R:1
   - 38/2 = 19 R:0
   - 19/2 = 9 R:1
   - 9/2 = 4 R:1
   - 4/2 = 2 R:0
   - 2/2 = 1 R:0
   - 1/2 = 0 R:1
   - 10011010010
   - 0.875 x 2 = 0.75 R:1
   - 0.75 x 2 = 0.5 R:1
   - 0.5 x 2 = 0.0 R:1
   - 10011010010
   - 1.0011010010 (moved 10 places)
   - 127 + 10 = 137 = 1000 1001
   - 1(sign) 1000 1001(exponent) 001 1010 010 111
   - 1100 0100 1001 1010 0101 1100 0000 0000
   - = C49A5C00

b. 7654.3
   - 7654/2 = 3827 R: 0
   - 3827/2 = 1913 R: 1

- 1913/2 = 956 R: 1
- 956/2 = 478 R: 0
- 478/2 = 239 R: 0
- 238/2 = 119 R: 1
- 119/2 = 59 R: 1
- 59/2 = 29 R: 1
- 29/2 = 14 R: 1
- 14/2 = 7 R: 0
- 7/2 = 3 R: 1
- 3/2 = 1 R: 1
- 1/2 = 0 R: 1
- 1110 1111 00110
- 0.3 x 2 0.6 R:0
- 0.6 x 2 = 0.2 R:1
- 0.2 x 2 = 0.4 R:0
- 0.4 x 2 = 0.8 R:0
- 0.8 x 2 = 0.6 R:1
- i0 1001(last 4 bits repeated)
- 1110 1111 00110.0 1001
- 1.110 1111 00110 0 1001 (moved 12 places)
- 12+ 127 = 139 = 1000 1011
- 0100 0101 1110 1111 0011 0010 0100 0000
- 45EF3240

8. .

a. FEDCBA98

- 1111 1110 1101 1100 1011 1010 1001 1000
- sign: 1 therefore negative
- exponent = 1111 1101 = 253 - 127 = 126
- number: 1.1011 1001 0111 0101 0011 000
- = 1.7244443893432617 X
- $2^{126} = 10^{X}$
- 126 log 2 = x log 10
- x = 126 log 2 = 37.9297777
- $-1.72444438934 \times 10^{37} \times 10^{0.929779453}$
- $-1.466995046607 \times 10^{38}$

b. 89ABCDEF

- = 1000 1001 1010 1011 1100 1101 1110 1111
- Sign: 1 therefore negative
- Exponent: 0001 0011
- 0001 0011 = 19
- 19 - 127 = -108
- M: 010 1011 1100 1101 1110 1111
- = 1.342222094535827
- 2^-108 = 10^x
- x = -108log 2 = -32.511239531
- -1.3422220945358 x 10^-32 x 10 ^-0.511239
- = -4.1360411582155291906 x 10^-33

9. .

a. FEDCBA98 + 89ABCDEF

- 1111 1110 1101 1100 1011 1010 1001 1000 + 1000 1001 1010 1011 1100 1101 1110 1111
- 1111 1110 1101 1100 1011 1010 1001 1000
  - sign 1 neg
  - exponent: 11111101 = 253
  - 253 - 127 = 126
  - M: 10111001011101010011000
  - -1.10111001011101010011000
- 1000 1001 1010 1011 1100 1101 1110 1111
  - sign 1 neg
  - Exponent: 0001 0011 = 19
  - 19 - 127 = -108
  - 01010111100110111101111
  - -1.01010111100110111101111
- -1.10111001011101010011000 X 2^(126) + -1.01010111100110111101111 X 2^(-108)
- = 1111 1110 1101 1100 1011 1010 1001 1000
- = FEDCBA98

b. 00FCD6EB + 80FCD6EA

- = 0000 0000 1111 1100 1101 0110 1110 1011 + 1000 0000 1111 1100 1101 0110 1110 1010
- 0000 0000 1111 1100 1101 0110 1110 1011:
  - sign: 0 pos
  - exponent: 0000 0001: 1
  - 1-127 = -126
  - 1.111 1110 1101 0110 1110 1011
- 1000 0000 1111 1100 1101 0110 1110 1010
  - sign: 1 neg
  - exponent: 0000 0001: 1
  - 1-127 = -126
  - 1.111 1110 1101 0110 1110 1010
  -
- Due to exponent being the same no need align for addition
- = 0.000 0010 0000 0000 0000 0001
- = $1.00000000 \times 2^{-149}$

- underflow because exponent below -126

c. 00FCD6EB + 09ABCDEF
   - 0000 0000 1111 1100 1101 0110 1110 1011 + 0000 1001 1010 1011 1100 1101 1110 1111
   - 0000 0000 1111 1100 1101 0110 1110 1011:
     - sign: 0 pos
     - exponent: 0000 0001: 1-127 = -126
     - 1.111 1110 1101 0110 1110 1011
   - 0000 1001 1010 1011 1100 1101 1110 1111
     - sign: 0 pos
     - exponent: 0001 0011: 19
     - 19 - 127 = -108
   - different exponents therefore must re-align
   - 1.01010111100110111101111 + 0.000000000000000000111111
   - = 1.01010111100111000101110 x 2^-108
   - 0000 1001 1010 1011 1100 1110 0010 1110
   - 9ABCE2E