

Computer Architecture HW3

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1. $91_{10} + C6_{16}$

To bin
 $91_{10} = \boxed{1011011_2}$

$2 \overline{) 91} \quad 1$
 $2 \overline{) 45} \quad 1$
 $2 \overline{) 22} \quad 0$
 $2 \overline{) 11} \quad 1$
 $2 \overline{) 5} \quad 1$
 $2 \overline{) 2} \quad 0$
 $2 \overline{) 1} \quad 1$

$C6_{16} = 11000110$
 $\swarrow \searrow$
 $1100 \quad 0110$
 $\searrow \swarrow$
 11000110

Dec-Hex

10	A
11	B
12	C
13	D
14	E
15	F

Both are unsigned.
 Both ~~are~~ will be represented as 9-bit unsigned.

$\begin{array}{r} 011000110 \\ + 001011011 \\ \hline 100100001 \end{array}$

Result is 9-bit unsigned

$1 + 32 + 256 = 33 + 256 = 289_{10}$

289

~~Do not want to convert to 9-bit result~~

2.

$$11_8 - 11_{10}$$

$$\begin{array}{r} 11 \\ 2 \overline{) 11} \\ 2 \overline{) 5} \\ 2 \overline{) 2} \\ 2 \overline{) 1} \\ 0 \end{array}$$

$$\begin{array}{r} 001001 \\ \hline 001001 \end{array}$$

$$11_8 = 1001$$

$$11_{10} = 1011$$

$$-11_{10} = 0101$$

All values represented as 4-bit signed (2's comp) integers.

$$\begin{array}{r} 1001 \\ + 0101 \\ \hline 1110 \end{array} \leftarrow \text{this is negative}$$

$$\begin{array}{r} 0001 + 0001 \\ \hline 0010 \end{array} \rightarrow 2_{10}, \text{ so}$$

$$\boxed{11_8 - 11_{10} = -2_{10}} \checkmark$$

3. $12.3125_{10} + 0110_{12Q2}$

$$12 \frac{5}{16}$$

So this must be

$$44Q4$$

$$01100101$$

$$\begin{array}{l} 0110_{12Q2} \\ \text{to } 44Q4 \\ 00011000 \end{array}$$

$$\begin{array}{r} 01100101 \\ + 00011000 \\ \hline 01111101 \end{array} \quad 44Q4$$

$$1 + 2 + 4 = 7$$

$$\frac{1}{2} + \frac{1}{4} + \frac{1}{16} = \frac{9}{16}$$

$$\boxed{7.8125_{10}}$$

$$4. \quad 5.75_{10} - 7.125_{10}$$

~~4#3 I3Q3~~ All #'s I4Q3 FXP

~~0101~~

$$7.125_{10}$$

$$0101110 = 5.75_{10}$$

$$0111001 = 7.125_{10}$$

$$10001101 = -7.125_{10}$$

$$1000111 = -7.125_{10}$$

$$\begin{array}{r} 0101110 \\ + 1000111 \\ \hline 1110101 \leftarrow \text{Negative, } \end{array}$$

$$1110101 \xrightarrow{\text{2's com.}} (0001011) \xrightarrow{\text{2's dec.}} 0001011$$

$$-(1 + \frac{1}{4} + \frac{1}{8}) = 1\frac{3}{8} = 1.375$$

$$5.75_{10} - 7.125_{10} = -1.375_{10}$$

$$5. \quad 9_{10} \cdot 3_{10}$$

Inputs are 4 bits

$$1001 = 9_{10}$$

$$0011 = 3_{10}$$

No. Unsigned 1001

Sign extend x0011

$$01001$$

$$+ 1001$$

$$11011 = 11_{10}$$

this is 11

$$1+2+8+32=43$$

$$1+2+8+16=27_{10}$$

$$6 - s_{10} \cdot -b_{10}$$

$$s_{10} \rightarrow 0101 \quad b_{10} \rightarrow 0110$$

$$-s_{10} \rightarrow \boxed{1011} \quad -b_{10} \rightarrow 1000 = \boxed{1010}$$

$\boxed{1011 \text{ and } 1010 \text{ are } I4}$

Sign extend

$$\begin{array}{r} 1011 \\ \times 1010 \\ \hline 0000 \\ 1011 \\ 0000 \\ \hline 1011 \\ \hline \boxed{110001110} \end{array}$$

$$\begin{array}{r} 1011 \\ 1010 \\ \hline 011 \\ \hline 1011 \\ \hline \boxed{1001110} \end{array}$$

$$\begin{array}{r} 1010 \\ 1011 \\ \hline 1010 \\ 101000 \\ 1010000 \\ \hline 0111110 \end{array}$$

0111110 is I7 and positive

$$2+4+8+16+$$

~~1001110 is I7 and is negative~~

$$\underline{\underline{0110001 + 1 = 0110010 = 2+16+32}}$$

No. Let's sign extend first $I4 * I4 = I8$

$$\begin{array}{r} 11111011 \\ \times 11111010 \\ \hline 11111011 \end{array}$$

$$\begin{array}{r} 11111011 \\ \times 11111010 \\ \hline 11111011 \\ 11111011 \\ 11111011 \\ 11111011 \\ 11111011 \\ 11111011 \\ 11111011 \\ \hline \boxed{00011110} \end{array}$$

Result is I8 and positive

$$00011110 = 2+4+8+16 = \boxed{30_{10}}$$

$$\boxed{-s_{10} \cdot -b_{10} = 30_{10}}$$

7. $9.5_{10} \cdot 2.625_{10}$

Two inputs are U4Q3
Result of mult. is then U8Q6

FXP

$$9.5_{10} = 8 + 1 + \frac{1}{2}$$

$$9.5_{10} = 1001100$$

$$2.625_{10} = 2 + \frac{1}{2} + \frac{1}{8}$$

$$2.625_{10} = 0010101$$

$$\begin{array}{r} 1001100 \\ \times 0010101 \\ \hline \text{Carry } \boxed{1}1001100 \\ \boxed{1}1001100 \\ \hline 1001100 \\ 1001100 \\ \hline 000100011100 \end{array}$$

1110

$$\cancel{1100011100} = 16 + 8 +$$

$$\boxed{10001100011100} \rightarrow 16 + 8 + \frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{16} = 24 + \frac{3}{4} + \frac{3}{16} = \boxed{24.9375}$$

Answer confirmed

to be U8Q6

(only need U5Q4 though)

$$Q. -1.25_{10} \cdot 3.5_{10}$$

Neg & Pos, so I req'd

~~Ex~~ I3 Q2 for inputs I6 Q4 for result EXP

$$1.25_{10} = 1 + \frac{1}{4}$$

$$= 001.01$$

$$\boxed{-1.25_{10} = 110.11_{I3Q2}}$$

$$3.5_{10} = 2 + 1 + \frac{1}{2}$$

$$\boxed{3.5_{10} = 0111.0_{I3Q2}}$$

$$\begin{array}{r}
 \begin{array}{c} 01110 \\ 11011 \end{array} \quad \begin{array}{c} \text{sign extend} \\ \hline 111111011 \\ \times 0000001110 \\ \hline 110111011 \\ 111111011 \\ \hline 111111011 \\ \hline \dots : 1111011010
 \end{array}
 \end{array}$$

100

1110111010 is I6Q4

and is negative

$$000100010111$$

$$- (00010001110_{I6Q4}) \text{ 2's comp}$$

$$\text{to dec.} = -\left(1 + \frac{1}{4} + \frac{1}{8}\right) = -\left(1 \frac{3}{8}\right) = -\left(1.375\right)$$

$$\boxed{-1.25_{10} \cdot 3.5_{10} = -4.375_{10}}$$

