

1a)

i) 20.25 in UQ16.16

$$\begin{array}{r|l} 2 & 20 \\ \hline 2 & 10 \quad 0 \\ 2 & 5 \quad 0 \\ 2 & 2 \quad 1 \\ 2 & 1 \quad 0 \\ & 0 \quad 1 \end{array} \quad 20_{10} = 10100_2$$

$$\begin{array}{r|l} 1/2 & 0.25 \\ \hline 1/2 & 0.5 \quad 0 \\ 1/2 & 1.0 \quad 1 \\ 1/2 & 1.0 \quad 0 \end{array} \quad 0.25_{10} = 0.01_2$$

$$20.25_{10} = 10010100.0100_2$$

$$= 0014.4000 \text{ (UQ16.16)}$$

ii)  $128.5$  in  $10116.16$

$$2 \overline{) 128}$$

$$2 \overline{) 64} \quad 0$$

$$132 \quad 0$$

$$\underline{116} \quad 0$$

$$8 \quad 0$$

$$4 \quad 0$$

$$2 \quad 0$$

$$1 \quad 0$$

$$0 \quad 1$$

$$128_{10} = 10000000_2$$

$$0.5_{10} = 0.0101_2$$

$$128.5_{10} = 10000000.0101$$

$$= 0080.5000_{16}$$

iii) 0.125 in VQ.16

$$\frac{1}{2} \underline{10.125}$$

$$0.125_{10} = 0.0010_2$$

$$\frac{1}{2} \underline{10.25} \quad 0$$

$$\frac{1}{2} \underline{10.5} \quad 0$$

$$\frac{1}{2} \underline{11.0} \quad 1$$

0

0000.2000

iv) -38.125. VQ15, 16

$$2 \underline{19}$$

$$38_{10} = 00100110_2$$

$$2 \underline{19} \quad 0$$

$$\text{inv: } 11011001$$

$$2 \underline{19} \quad 11$$

$$+1: 1011011$$

$$2 \underline{14} \quad 1$$

$$11011010$$

$$2 \underline{12} \quad 0$$

$$2 \underline{11} \quad 0$$

$$10$$

$= 80DA.2000$

v)  $-50.0625$  in  $UD15.16$

$2 \overline{) 50}$		$50_{10} = 110010_2$
$2 \overline{) 25}$	0	
$2 \overline{) 12}$	1	001101
$2 \overline{) 6}$	0	1
$2 \overline{) 3}$	0	1001111
$2 \overline{) 1}$	1	$2^5$
0	1	$-50_{10} = 1001111$

$$\frac{1}{2} \overline{) 0.0625}$$

$$\frac{1}{2} \overline{) 0.125} \quad 0$$

$$\frac{1}{2} \overline{) 0.25} \quad 0$$

$$\frac{1}{2} \overline{) 0.5} \quad 0$$

$$\frac{1}{2} \overline{) 1.0} \quad 1$$

$$0.0625_{10} = 0.0001$$

$$\boxed{= 804F.1000}$$

1b)

i) 0.141 in half precision / format

$$\frac{1}{2} \mid 0.141$$

$$\frac{1}{2} \mid 0.282 \quad 0$$

$$\frac{1}{2} \mid 0.564 \quad 0$$

$$\frac{1}{2} \mid 1.128 \quad 1$$

$$\frac{1}{2} \mid 0.256 \quad 0$$

$$\frac{1}{2} \mid 0.512 \quad 0$$

$$\frac{1}{2} \mid 1.024 \quad 1$$

$$\frac{1}{2} \mid 0.048 \quad 0$$

$$\frac{1}{2} \mid 0.096 \quad 0$$

$$\frac{1}{2} \mid 0.192 \quad 0$$

$$\frac{1}{2} \mid 0.384 \quad 0$$

$$\frac{1}{2} \mid 0.768 \quad 0$$

$$\frac{1}{2} \mid 1.536 \quad 1$$

$$1.062 \quad 1$$

$$S = 0$$

$$0.0010010000 = 1.001 \times 2^{-3}$$

$$E = 15 - 3 = 12 = 01100$$

$$F = 0010000011$$

$$X = SEF$$

$$X = 001100000100000011$$

$$X = 0011000010000011$$

$$X = B083_{16}$$

$$X = F \times 2^{12}$$

ii) 3.625 in half precision format

$$3_{10} = 0011_2 \quad \underline{S=0}$$

$$\begin{array}{r} \frac{1}{2} \overline{) 0.625} \\ \underline{1.25} \phantom{0} \\ 10.5 \phantom{0} \\ \underline{11.0} \phantom{0} \\ 0 \phantom{0} \\ \dots \phantom{0} \end{array}$$

$$\frac{1}{2} \overline{) 1.25} \quad 1$$

$$\frac{1}{2} \overline{) 10.5} \quad 0$$

$$\frac{1}{2} \overline{) 11.0} \quad 1$$

$$0 \quad 0$$

$$\dots \quad 0$$

$$3.625_{10} = 0011.1010_2$$

$$= 1.101 \times 2^1$$

$$E = 15 + 1 = 16$$

$$= 10000$$

$$F = 101$$

$$X = 0100001101000000$$

$$\boxed{X = 4340_{16}}$$

iii) -15.25 in half precision format

$$2 \overline{) 15}$$

$$2 \overline{) 7} \quad 1$$

$$2 \overline{) 3} \quad 1$$

$$2 \overline{) 1} \quad 1$$

$$10 \quad 1$$

$$S = 1$$

$$-15.25_{10} = 1111.0100_2$$

$$S = 1.1110100 \times 2^3$$

$$\frac{1}{2} \overline{) 10.25}$$

$$\frac{1}{2} \overline{) 10.5} \quad 0$$

$$\frac{1}{2} \overline{) 11.0} \quad 1$$

$$0$$

$$E = 15 + 3 = 18$$

$$= 10010$$

$$F = 1110100000$$

$$X = 1100101110100000$$

$$X = CBAC_{16}$$

2a)  $15.25 + 4.125$  (Floating point)

①

$$15.25_{10} = 1111.0100_2 = 11.1101 \times 2^2$$

$$4.125_{10} = 0100.0010_2 = 1.00001 \times 2^2$$

②

$$\Rightarrow (11.1101 + 1.00001) \times 2^2$$

$$\begin{array}{r} 11.11010 \times 2^2 \\ + \end{array}$$

$$\begin{array}{r} 1.00001 \times 2^2 \\ \hline \end{array}$$

$$100.11011 \times 2^2$$

③

$$= 1.0011011 \times 2^4$$

④

$$S = 0$$

$$E = 15 + 4 = 19_{10} = 10011$$

$$F = 0011011000$$

⑤

$$X_F = 0100\ 1100\ 1101\ 1000_2$$

$$= 4CD8_{16}$$



$$2b) 15.25 - 4.125$$

$$15.25$$

$$\Rightarrow 1111.0100 = 1.11101 \times 2^3$$

$$-4.125_{10} = (-4)_{10} + (-0.125)_{10}$$

$$-0100_2 + -0.0010_2$$

$$\begin{array}{r} \text{Invert + 1: } 1011 \\ + \quad \quad \quad 1 \\ \hline 1100 \end{array} \quad \begin{array}{r} 1.1101 \\ \downarrow \\ 1 \\ \hline 111.1110 \end{array}$$

$$\begin{array}{r} 11100.0000 \\ + 1111.1110 \\ \hline 111011.1110 = -4.125 \end{array}$$

$$= 11.011110 \times 2^3 \quad \text{then,}$$

$$(1.11101 + 11.01111) \times 2^3 \Rightarrow \begin{array}{r} 01.111010 \\ 11.01111 \\ \hline 101.011001 \times 2^3 \end{array}$$

$$S = 1_2$$

$$E = 20_{10} = 10100_2$$

$$F = 0101100100$$

$$= 1.01011001 \times 2^5$$

$$\boxed{X = 1101000101100100_2}$$

$$= 0164_{16}$$