(1) 4-bit 2's complement floating-point

a) Largest Positive:

$$0.111 \times 2^{7} = \frac{7}{8} \times 128 = \underline{\underline{112_{10}}}$$

b) Largest Negative:

$$1.000 \times 2^{7} = -1 \times 128 = \underline{\underline{-128_{10}}}$$

c) Smallest Fraction:

$$0.001 \times 2^{-8} = \frac{1}{8} \times \frac{1}{256} = \frac{1}{2048}$$

$$\approx 4.88 \times 10^{-4}$$

(2) a) $\left(\frac{3}{8}\times 2^{3}\right)\times\left(-\frac{1}{2}\times 2^{-1}\right) = ? = 3\times -\frac{1}{4} = -\frac{3}{4}$

$N_1 = \frac{3}{8}\times 2^{3}$

$= \underbrace{0.011}_{F_1} \times 2^{\overbrace{0011}^{E_1}}$

$N_2 = -\frac{1}{2}\times 2^{-1}$

$= -0.100 \times 2^{-0001}$

$= \underbrace{1.100}_{F_2} \times 2^{\overbrace{1111}^{E_2}}$

$F_1 \times F_2$:

$$\begin{array}{r} 0.011 \\ \times\ 1.100 \\ \hline 0.001100 \\ 1.101 \\ \hline 1.110100 \end{array}$$

$E_1 + E_2$:

$$\begin{array}{r} {}^{1}{}^{1}{}^{1} \\ 0011 \\ +\ 1111 \\ \hline 0010 \end{array}$$

$$\begin{array}{r} 0010 \\ -(0010) \\ \hline 0000 \end{array}$$

$\underbrace{0000}_{E}$

Normalize (×2?) $\underbrace{1.010}_{F}000$

$N = 1.010 \times 2^{0}$

$= -(0.110)\times 1 = -3/4$ ✓

ALT: Normalize N_1 & N_2 before mult.

$N_1 = 0.011 \times 2^{0011}$

$= \underbrace{0.110}_{F_1} \times 2^{\overbrace{0010}^{E_1}}$

$N_2 = 1.100 \times 2^{-0001}$

$= 1.000 \times 2^{-0010}$

$= \underbrace{1.000}_{F_2} \times 2^{\overbrace{1110}^{E_2}}$

$F_1 \times F_2$:

$$\begin{array}{r} 0.110 \\ \times\ 1.000 \\ \hline \underbrace{1.010}_{F}000 \end{array}$$ Norm ✓

$E_1 + E_2$:

$$\begin{array}{r} {}^{1}{}^{1} \\ 0010 \\ +\ 1110 \\ \hline \underbrace{0000}_{E} \end{array}$$

$N = 1.010 \times 2^{0}$

$= -(0.110)\times 1 = -3/4$ ✓

2b) $F_1 = 1.011$ $E_1 = 0101$

$F_2 = 1.010$ $E_2 = 0100$

$N_1 = 1.011 \times 2^{0101}$

$= -(0.101) \times 2^5$

$= -\frac{5}{8} \times 32 = -20$

$N_2 = 1.010 \times 2^{0100}$

$= -(0.110) \times 2^4$

$= -\frac{3}{4} \times 16 = -12$

$N_1 \times N_2 = (-20) \times (-12) = +240 > +112$

overflow!

$F_1 \times F_2 =$

```
    1.011
    1.010
  1.11 0110
    0.101
  0.0,11110
```

Not Norm

2SF 0.1111100

$E_1 + E_2 =$

```
  0101
+ 0100
  1001
```

2's C E $\uparrow 1111$

```
  1000
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↑ Exponent overflow ✓

(3) a) $25.25_{10} = 11001.01_2$

$= 1.100101 \times 2^4 \Rightarrow E = 127 + 4$

$= 131$

S E F

0 10000011 10010100...

4 1 C A 0000

b) $-7.5_{10} = -111.1 = -1.111 \times 2^2 \Rightarrow E = 127 + 2$

$= 129$

S E F

1 10000001 11100...

C 0 F 0 0000

c) $-63.125 = -111111.001_2$

$= -1.11111001 \times 2^5 \Rightarrow E = 127 + 5$

$= 132$

S E F

1 10000100 11111001000...

C 2 7 C 8 000