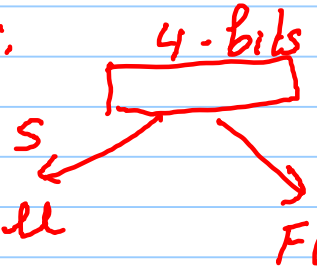
Note Title 8/4/2016

4-bit number system

1) Sign magnitude
   - → Two 0s
   - → Arithmetic operations (hard)

2) Biased:



$F(u) = u + 7$

$(0 \le F(u) \le 15)$

Examples: $F(-3) = 0100$

$F(0) = 0111$

$F(4) = 1011$

1 repⁿ for 0

$F(4) = 1011$

$F(0) = 0111$ +

0010

$1\square\square\square \geq 8^{F(4)}$ $(4 \geq 1)$

$0\square\square\square$

- ✓ Sign bit
- ✓ +, −
- ✓ 1 rep. for 0

3) 1s complement

$F(u) = u \quad (0 \le u \le 7)$

$F(u) = \sim u \quad (-7 \le u < 0)$

$(15 - |u|)$

$F(3) = 0011$ $\qquad$ $F(4) = \bar{0}100$

$F(-3) = \bar{1}100$ $\qquad$ $F(-4) = \bar{1}011$

$F(1) = \bar{0}001$ $\qquad$ $F(0) = \bar{0}000$

$F(-1) = \bar{1}110$ $\qquad$ $F(-0) = 1111$

$$\begin{array}{r} 0011 \\ +1100 \\ \hline 1111 \end{array}$$

$$\begin{array}{r} 0001 \\ +0010 \\ \hline 0011 \end{array}$$

$F(4) = 0100$

$F(-3) = 1100 +$

0000

$F(-2) = 15 - 2$

$15 \rightarrow 1111$

$-2 \quad 0010$

1101

$F(2) = 0010$

$F(-2) = 1101$

Repⁿ of 0 → ×

sign bit → ✓

+, − → 1/4

$-2 + (-3)$

$F(-2) = 1101$

$F(-3) = 1100$ +

$F(-6) = 1001$

2s complement

$$F(u+v) = F(u) + F(v)$$

$$\begin{array}{rl} 2+3 = & 0010 \\ & +0011 \\ \hline 5 & 0101 \end{array}$$

$$\begin{array}{rl} 2 & 0010 \\ +(-3) & +\ 1101 \\ \hline (-1) & 1111 \end{array}$$

$-3 + (-2)$

$-3 \rightarrow 1101$

$-2 \rightarrow 1110$

$-5 \rightarrow 1011$

3×2

$(3) \times (-2) = 13 \times 14$

$= 182$

$= 6$

$$\begin{array}{r} 0011 \\ 0010 \\ \hline 0000 \\ 0011 \\ \hline 00110 \end{array}$$

$3 \times (-2)$

$= 3 \times (14)$

$= 42$

$(6) = 10\ (-6)$

$$F(u+v) \equiv F(u) + F(v)$$

$$F(u \times v) \equiv F(u) \times F(v)$$

$$F(u \times v) \equiv F(u) \times F(v)$$

$$u \times (2^n - |v|)$$

$$= 2^n \times u - u|v|$$

$$\equiv -u|v|$$

u +ve

v -ve

4-bit	8-bit
0011	0000 0011
0101	0000 0101
1100	1111 1100
(-4)	(252)
	-4