negative numbers via "2s complement" = 1s complement + 1

eg: $3_{10} = 0011 \xrightarrow[\text{comp}]{} 1100 \xrightarrow[+1]{} 1101 = {}^{-}3$

Note: $3 + {}^{-}3 = 0$

$$\begin{array}{r} 0011 \\ 1101 \\ \hline 1\,0000 \end{array}$$

ignore carry

→ "signed" or "unsigned" integers

⋮	
0011	= 3
0010	= 2
0001	= 1
0000	= 0
1111	= −1
1110	= −2
1101	= −3
⋮	

range −8 = 1000
to +7 = 0111

fractions: $3.14159\ldots = 11.001001000011\ldots$

$$= 2 + 1 + \frac{1}{8} + \frac{1}{64} + \frac{1}{2048} + \frac{1}{4096} \ldots$$

$$= 3.14136$$

continue to scientific notation: $.11001 \times 2^2$

need bits for sign, exponent & fraction

→ "real" number → range limited by # bits used for expo
aka "float" precision limited by # bits used for fraction

Binary Coded Decimal: use 4 bits for each decimal digit

eg $351_{10} = \underbrace{0011}_{3}\ \underbrace{0101}_{5}\ \underbrace{0001}_{1}$

"BCD"

plan: "simplest" circuit ⟷ algebra → "simplest"

circuit ⟷ Truth Table ⟷ algebra

Truth Table ⟷ word description of problem

Vocab: byte = 8 bits

nibble = 4 bits = 1 hex digit

TABLE 8.3. LOGIC IDENTITIES

$ABC = (AB)C = A(BC)$

$AB = BA$

$AA = A$

$A1 = A$

$A0 = 0$

$A(B+C) = AB + AC$

$A + AB = A$ ← AB adds nothing to A

$A + BC = (A + B)(A + C)$ ← distribute + over • !

$A + B + C = (A + B) + C = A + (B + C)$

$A + B = B + A$

$A + A = A$ } Note: 1+1 = 1

$A + 1 = 1$

$A + 0 = A$

$1' = 0$

$0' = 1$

$A + A' = 1$

$AA' = 0$

$(A')' = A$

$A + A'B = A + B$

Pf $= A + B(A + \bar{A}) = \underbrace{A + BA}_{= A \text{ (see above)}} + B\bar{A}$

$(A + B)' = A'B'$ } Think: "distribute the bar" with $\overline{+} = \cdot$

$(AB)' = A' + B'$

Eg: $xyz + \bar{x}\bar{y}z + \bar{x}yz + \bar{x}y\bar{z} + \bar{x}\bar{y}\bar{z}$

$= (x+\bar{x})yz = yz$

$= \bar{x}\bar{y}(z+\bar{z}) = \bar{x}\bar{y}$

$= yz + \bar{x}\bar{y} + \bar{x}y\bar{z}$

$= \bar{x}(\bar{y} + y\bar{z}) = \bar{x}\cdot(\bar{y}+\bar{z})$

$= yz + \bar{x}\bar{y} + \bar{x}\bar{z}$ (A)

or $= y(z + \bar{x}\bar{z}) = y(z+\bar{x})$

$= \bar{x}\bar{y} + yz + y\bar{x}$

$= \bar{x}(\bar{y}+y) = \bar{x}$

$= \bar{x} + yz$ (B)

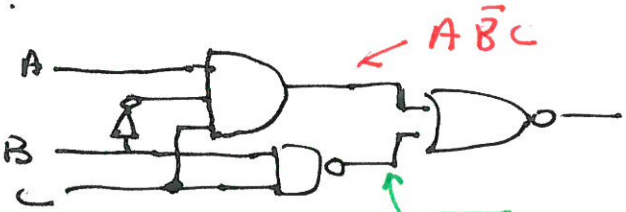
Note: (A) & (B) look different but are the same

→ different routes yield different looking results
here we can show they are the same with a trick: (A) $= yz + \bar{x}(\bar{y}+\bar{z})$

$= yz + \bar{x}\,\overline{yz}$

$= yz + \bar{x}$

Circuits:



$\overline{(A\bar{B}C + \overline{BC})}$

$=$

$\overline{(A\bar{B}C + \bar{B} + \bar{C})}$

$=$

$\overline{(\bar{B}+\bar{C})}$

$=$

BC

same as