

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

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

- ∴
- 0011 = 3
- 0010 = 2
- 0001 = 1
- 0000 = 0
- 1111 = -1
- 1110 = -2
- 1101 = -3
- ∴

Note: $3 + -3 = 0$

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

ignore carry →

range -8 = 1000
to +7 = 0111

→ "signed" or "unsigned" integers

Fractions: $3.14159... = 11.001001000011...$

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

$$= 3.14136$$

Continue to scientific notation: 1.1001×2^2

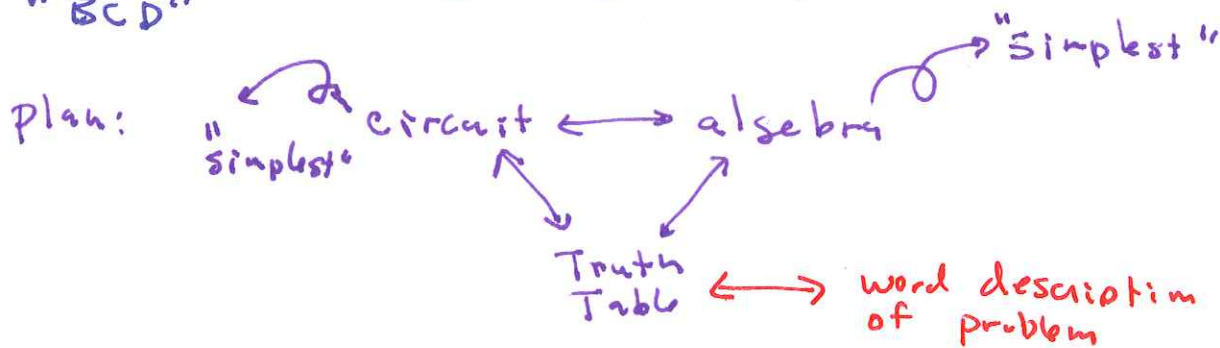
need bits for sign, exponent & fraction

→ "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 $351_{10} = \underbrace{0011}_3 \quad \underbrace{0101}_5 \quad \underbrace{0001}_1$

"BCD"



Vocab: byte = 8 bits

nibble = 4 bits = 1 hex digit

TABLE 8.3. LOGIC IDENTITIES

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

$$AB = BA$$

$$AA = A$$

$$A1 = A$$

$$A0 = 0$$

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

$$A + AB = A \quad \leftarrow AB \text{ adds nothing to } A$$

$$A + BC = (A + B)(A + C) \quad \leftarrow \text{distribute } + \text{ over } \cdot !$$

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

$$A + B = B + A$$

$$A + A = A$$

$$A + 1 = 1$$

$$A + 0 = A$$

$$1' = 0$$

$$0' = 1$$

$$A + A' = 1$$

$$AA' = 0$$

$$(A')' = A$$

$$A + A'B = A + B$$

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

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

} note: $1+1=1$

= A (see above)

Pf $= A + B \cdot (A + \bar{A}) = \overbrace{A + BA} + B\bar{A}$

} Think: "distribute the bar" with $\overline{+} = \cdot$

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

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

$$= \bar{x} \bar{y} (1 + z) = \bar{x} \bar{y}$$

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

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

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

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

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

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

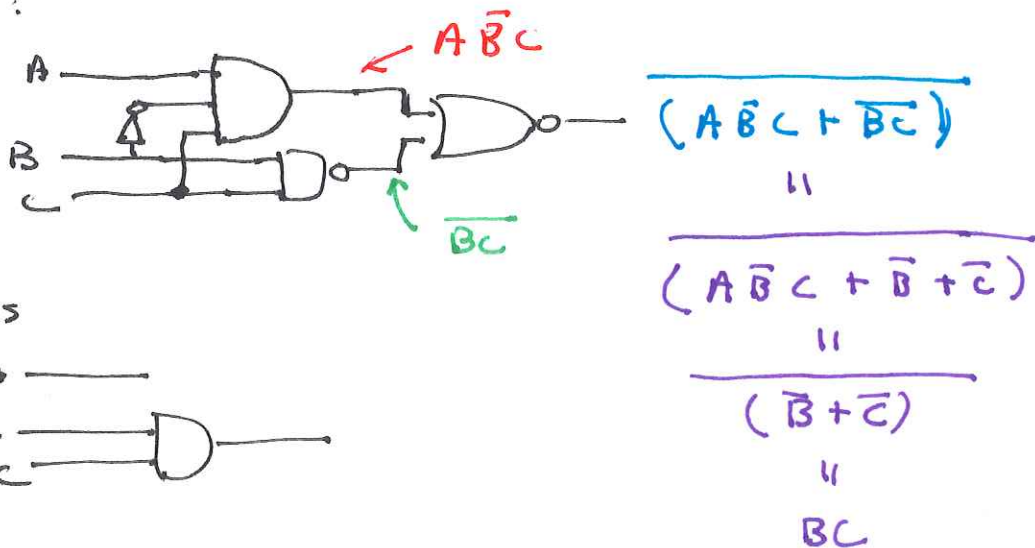
$$= \bar{x} + y z \quad \text{(B)}$$

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 truth table: (A) = $y z + \bar{x} (\bar{y} + \bar{z})$

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

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

Circuits:



Same as

