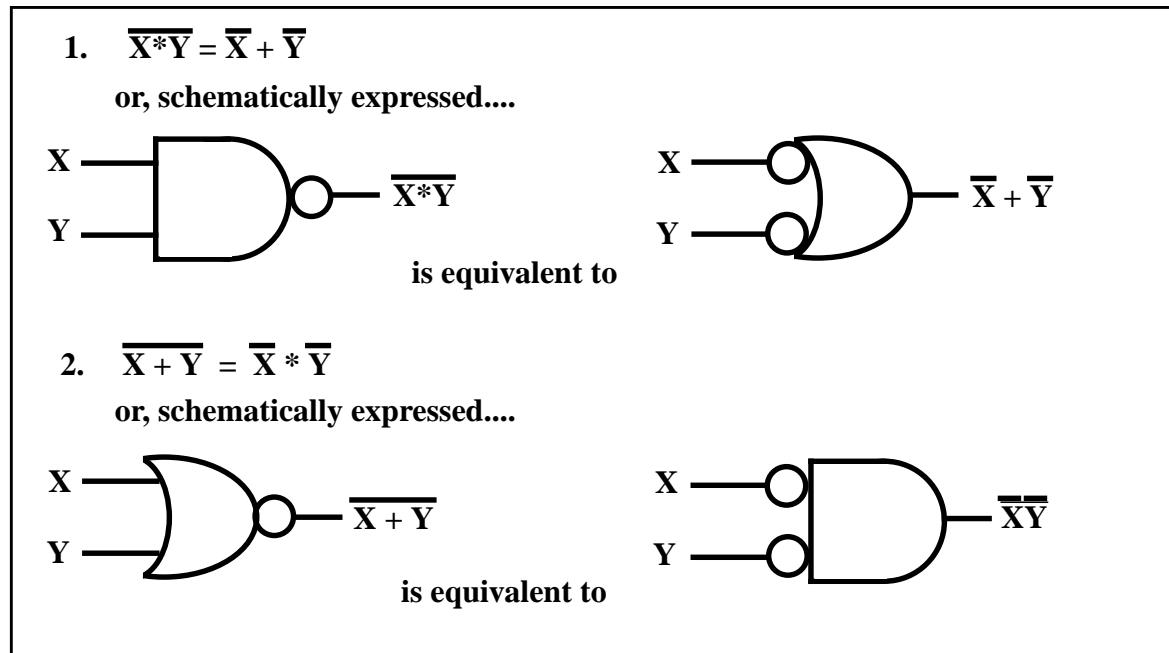# DeMorgan's Theorems

Two extremely important logic laws are called De Morgan's Theorems. They are stated as follows:.

1. $\overline{X*Y} = \overline{X} + \overline{Y}$

   or, schematically expressed....

X ——
Y —— $\overline{X*Y}$

is equivalent to

X ——
Y —— $\overline{X} + \overline{Y}$

2. $\overline{X + Y} = \overline{X} * \overline{Y}$

   or, schematically expressed....

X ——
Y —— $\overline{X + Y}$

is equivalent to

X ——
Y —— $\overline{\overline{X}\overline{Y}}$

Demorgan's theorem makes it easy to transform POS to SOP or SOP to POS forms. For example:

Convert the equation: $(ABC) + (A\overline{B}C) + (\overline{A}\overline{B}C) = Z$ to POS form.

First, double negate the entire equation.

$$\overline{\overline{(ABC) + (A\overline{B}C) + (\overline{A}\overline{B}C)}} = \overline{\overline{Z}}$$

Secondly, distribute the outer negation using De Morgan's Theorem.

$$\overline{\overline{(ABC)} * \overline{(A\overline{B}C)} * \overline{(\overline{A}\overline{B}C)}} = \overline{\overline{Z}}$$

Finally, distribute the inner negations using De Morgan's Theorem.

$$(\overline{A}+\overline{B}+\overline{C}) * (\overline{A}+B+\overline{C}) * (A+B+\overline{C}) = Z$$