De Morgan's Theorems

Electrical Engineering

Break the bar, change the operator — and why NAND and NOR are universal.

Complementing a group flips the operator underneath it, and complements each term.

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

$(AB)'$ → **$A' + B'$**

NAND as an OR.

$(A + B)'$ → **$A'B'$**

NOR as an AND.

$(A + B'C)'$ → **$A'(B + C')$**

Work outside in.

THE COMMON MISTAKE

× **Splitting the bar but keeping the operator**

✓ **Break the bar and change the sign together**

The operator swaps every time a bar is split. Leaving AND as AND gives an expression wrong for half the input combinations.

This is exactly why NAND and NOR are universal: De Morgan redraws any network in one gate type without changing behaviour.