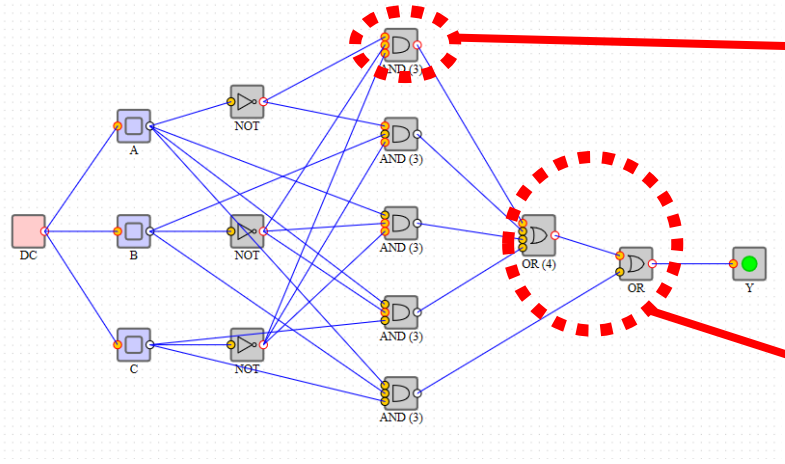
Exercise 1.

a. $Y = \bar{A} \cdot \bar{B} \cdot \bar{C} + \bar{A} \cdot B \cdot \bar{C} + A \cdot \bar{B} \cdot \bar{C} + A \cdot \bar{B} \cdot C + A \cdot B \cdot C$



The 3-input AND gate here can be implemented using two 2-input AND gates: the first AND gate takes $\bar{A}$ and $\bar{B}$ as inputs, and the second AND gate takes as inputs the output of the first gate and $\bar{C}$.

This is equivalent to a 5-input OR gate that takes the outputs of the five AND gates as inputs.

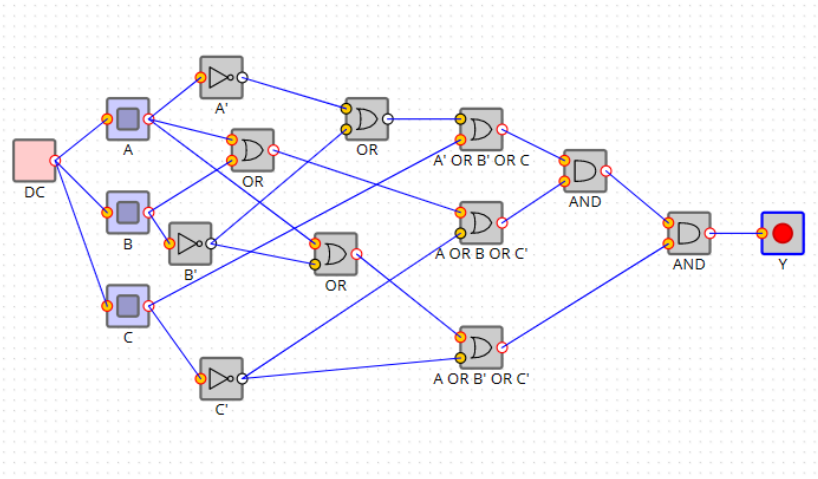
b. $$Y = \bar{A} \cdot \bar{B} \cdot \bar{C} + \bar{A} \cdot B \cdot \bar{C} + A \cdot \bar{B} \cdot \bar{C} + A \cdot \bar{B} \cdot C + A \cdot B \cdot C$$

$$Y = \bar{A} \cdot \bar{B} \cdot \bar{C} + \bar{A} \cdot B \cdot \bar{C} + A \cdot \bar{B} \cdot \bar{C} + A \cdot \bar{B} \cdot C + A \cdot \bar{B} \cdot C + A \cdot B \cdot C$$

$$Y = (\bar{A} \cdot \bar{B} \cdot \bar{C} + \bar{A} \cdot B \cdot \bar{C}) + (A \cdot \bar{B} \cdot \bar{C} + A \cdot \bar{B} \cdot C) + (A \cdot \bar{B} \cdot C + A \cdot B \cdot C)$$

$$Y = \bar{A} \cdot \bar{C} + A \cdot \bar{B} + A \cdot C$$

c. $Y = (A + B + \bar{C}) \cdot (A + \bar{B} + \bar{C}) \cdot (\bar{A} + \bar{B} + C)$



d. $Y = (A + \bar{C}) \cdot (\bar{A} + \bar{B} + C)$

Exercise 2.

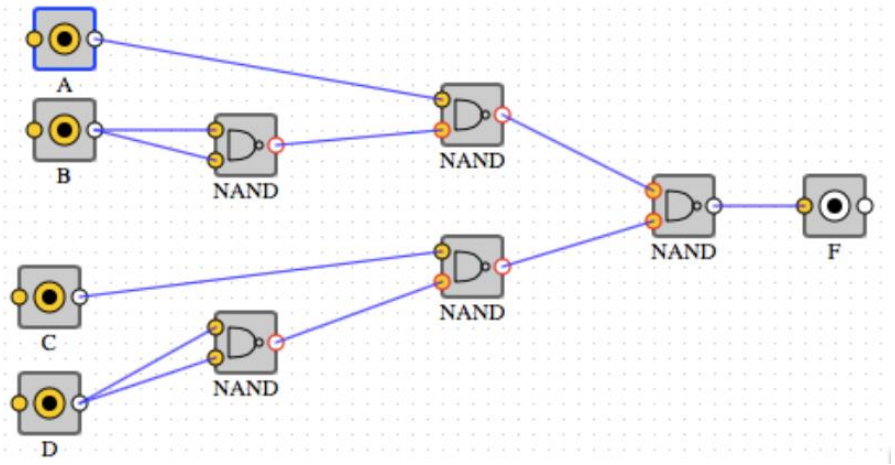
$$F = AB' + CD'$$

$$= (AB')' \text{ NAND } (CD')'$$

$$= (A' + B) \text{ NAND } (C' + D)$$

$$= (A \text{ NAND } B') \text{ NAND } (C \text{ NAND } D')$$

$$= \big(A \text{ NAND } (B \text{ NAND } B)\big) \text{ NAND } (C \text{ NAND } (D \text{ NAND } D))$$



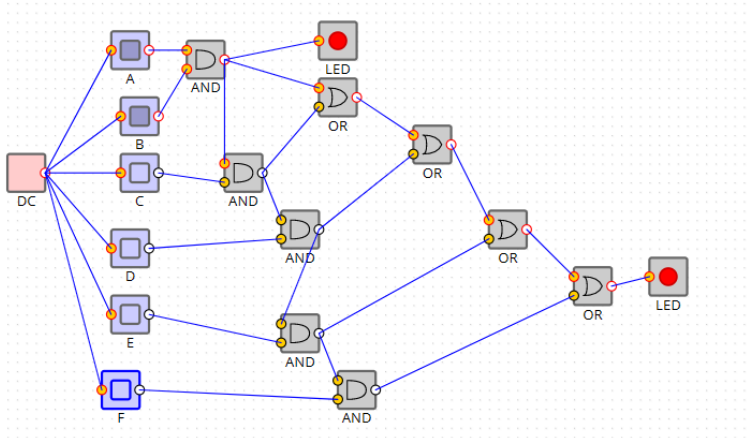
Exercise 3.

$$\overline{A+B}\cdot\overline{C+D+E}+\overline{A+B} = \overline{A+B}\cdot(\overline{C+D+E}+1) = \overline{A+B} = \bar{A}\cdot\bar{B}$$

Exercise 4.

$$\mathrm{AB}+\mathrm{ABC}+\mathrm{ABCD}+\mathrm{ABCDE}+\mathrm{ABCDEF} = AB$$

You can verify the correction of the above either by checking the truth table for all possible combinations of values for the six inputs, or by creating the corresponding circuit, e.g.



You can also simply notice that the left-hand side expression is true only when both A and B are true, irrespectively of the values of the other variables.

Exercise 5.

AB \ C	0	1
00	1	0
01	1	0
11	0	1
10	1	1

The resulting expression is $\bar{A}\,\bar{C}+A\,\bar{B}+AC$. It is the same as the expression in 1.b.