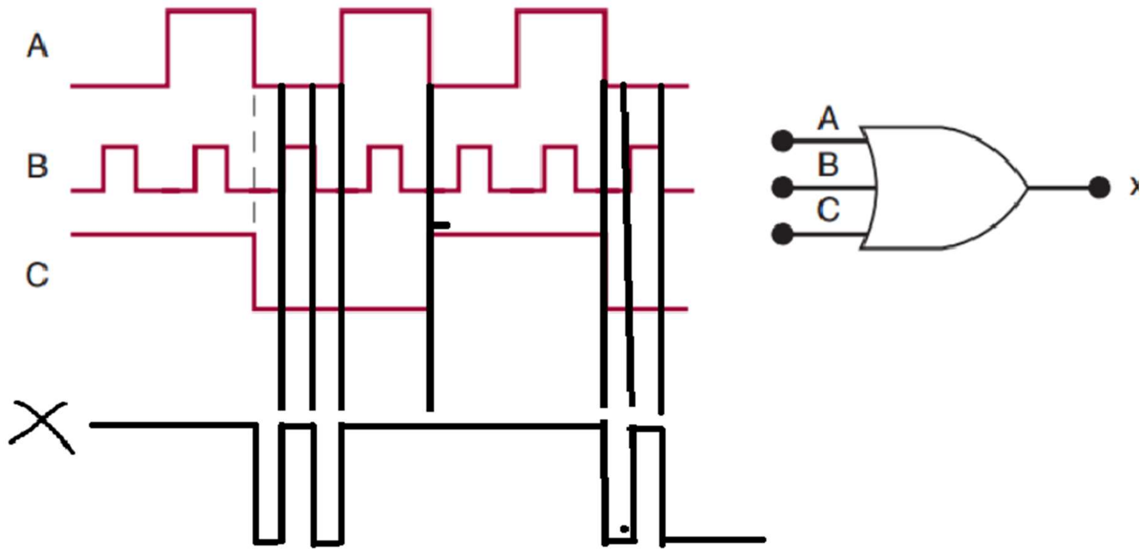
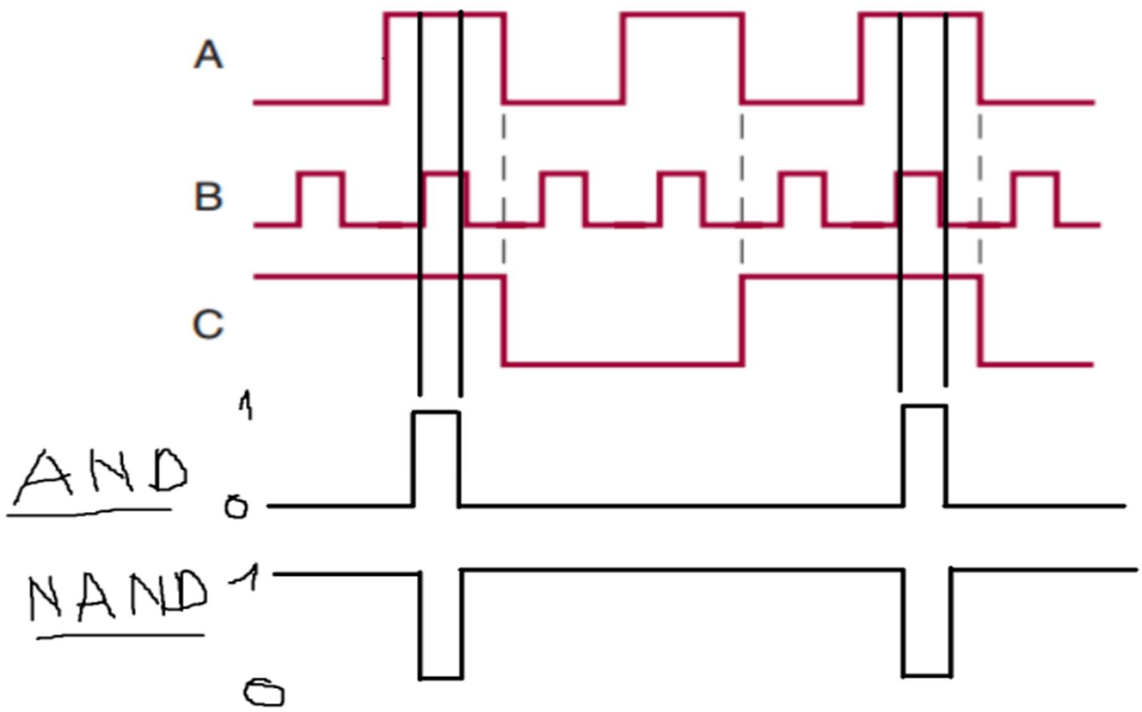
1. Draw a output waveform for the OR gare

OR gate

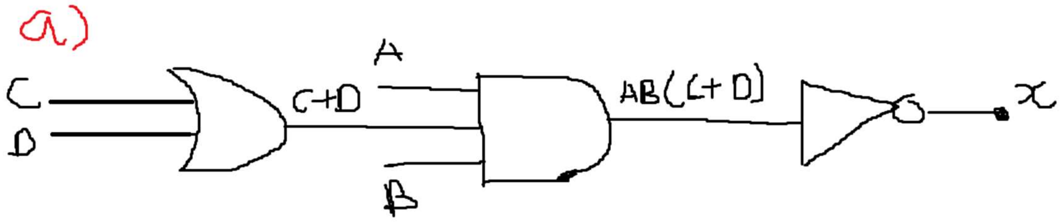


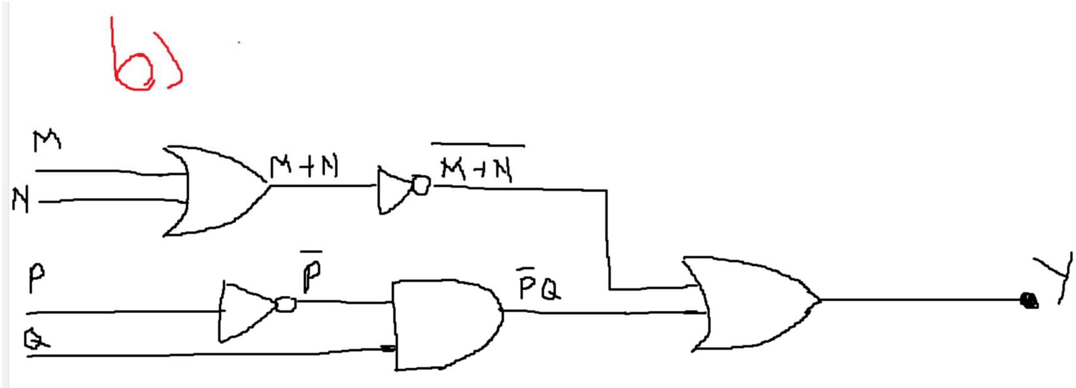
NAND gate

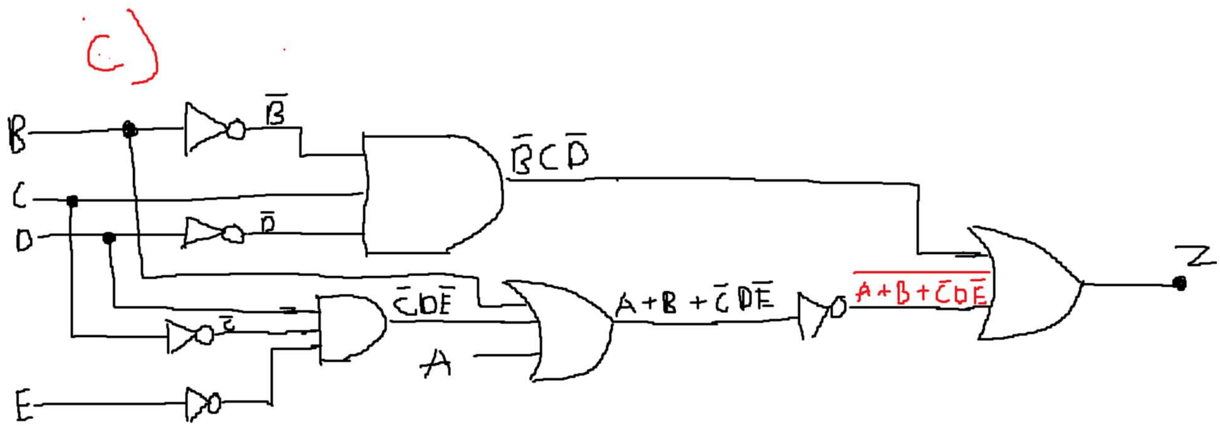


3. For each of the following expressions, construct the corresponding logic circuit, using AND and OR gates and INVERTERs
   a. $x = \overline{AB(C + D)}$
   b. $y = (\overline{M + N} + \overline{P}Q)$
   c. $z = \overline{A + B + \overline{C}D\overline{E}} + \overline{B}C\overline{D}$

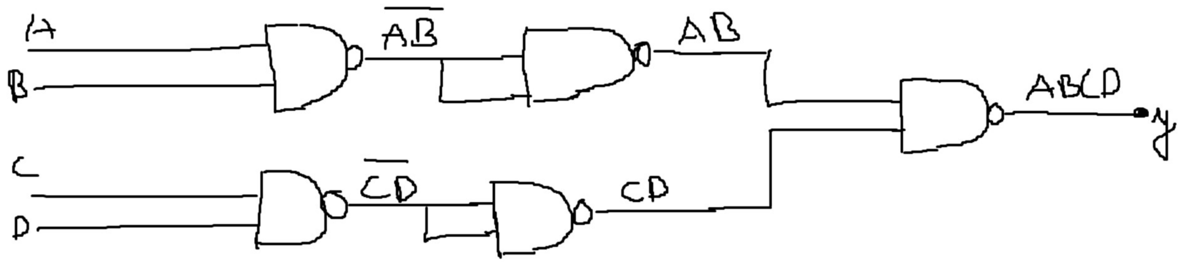
a)





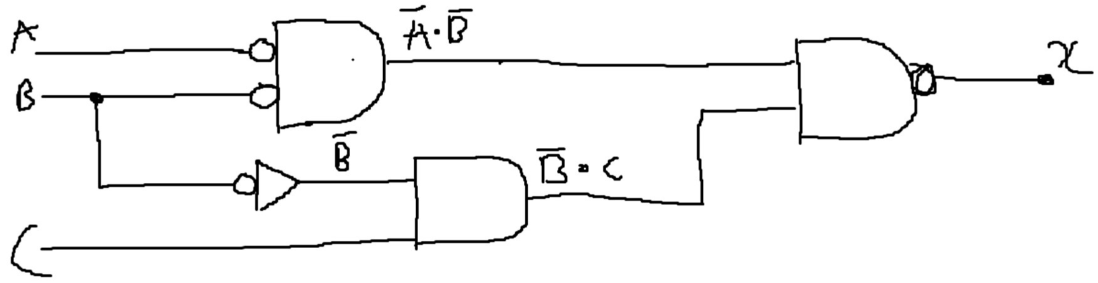


5. Implement y = ABCD using only **two-input NAND gates**.



7. The circuit of Figure 2b is supposed to be a simple digital combination lock whose output will generate an active-LOW signal for only one combination of inputs.
   a. Modify the circuit diagram so that it represents more effectively the circuit operation.
   b. Use the new circuit diagram to determine the input combination that will activate the output.

a)



b)

A	B	C	$\bar{A}\bullet\bar{B}$	$\bar{B}\bullet C$	X
0	0	0	1	0	1
0	0	1	1	1	0
0	1	0	0	0	1
0	1	1	0	0	1
1	0	0	0	0	1
1	0	1	0	1	1
1	1	0	0	0	1
1	1	1	0	0	1

9. Simplify the following expression using Boolean algebra

   a. $x = \overline{A}\,\overline{B}\,\overline{C} + \overline{A}\,B\,C + A\,B\,C + A\,\overline{B}\,\overline{C} + A\,\overline{B}\,C$

   b. $y = \left(\overline{C + D}\right) + \overline{A}\,C\,\overline{D} + A\,\overline{B}\,\overline{C} + \overline{A}\,\overline{B}\,C\,D + A\,C\,\overline{D}$

   c. $z = \left(B + \overline{C}\right)\left(\overline{B} + C\right) + \overline{\overline{A} + B + \overline{C}}$

a)

$$
\begin{aligned}
x &= \overline{A}\overline{B}\overline{C} + \overline{A}BC + ABC + A\overline{B}\overline{C} + A\overline{B}C \\
&= \overline{A}\overline{B}\overline{C} + BC(A + \overline{A}) + A\overline{B}(C + \overline{C}) \\
&= \overline{A}\overline{B}\overline{C} + BC + A\overline{B} \\
&= BC + \overline{B}(\overline{A}\overline{C} + A) \\
&= BC + \overline{B}(A + \overline{C})
\end{aligned}
$$

b) From b) we have

$$
\begin{aligned}
y &= \overline{C}\overline{D} + \overline{A}C\overline{D} + A\overline{B}\overline{C} + \overline{A}\overline{B}CD + AC\overline{D} \\
&= \overline{C}\overline{D} + C\overline{D}(\overline{A} + A) + A\overline{B}\overline{C} + \overline{A}\overline{B}CD \\
&= \overline{C}\overline{D} + C\overline{D} + A\overline{B}\overline{C} + \overline{A}\overline{B}CD \\
&= \overline{D}(C + \overline{C}) + A\overline{B}\overline{C} + \overline{A}\overline{B}CD \\
&= \overline{D} + A\overline{B}\overline{C} + \overline{A}\overline{B}CD
\end{aligned}
$$

c) From c) we have

$$
\begin{aligned}
z &= B\overline{B} + BC + \overline{B}\overline{C} + C\overline{C} + \overline{\overline{A}}\overline{B}\overline{\overline{C}} \\
&= BC + \overline{B}\overline{C} + A\overline{B}C \\
&= BC + \overline{B}(\overline{C} + AC) \\
&= BC + \overline{B}(\overline{C} + A) \\
&= BC + \overline{B}\overline{C} + A\overline{B}
\end{aligned}
$$