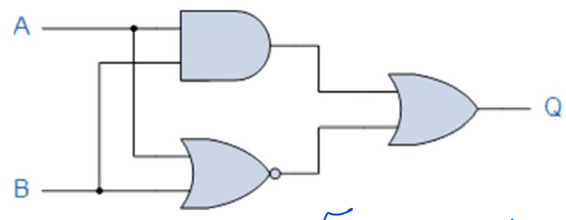
Name: Solution **Documentation**: None

1. Construct a truth table from the following logic circuit diagram. The table should have two columns for the inputs and a column for the output.



A	B	Q
0	0	1
0	1	0
1	0	0
1	1	1

For input 00:
$AB = 0$ and $\overline{A+B} = 1$, so
$Q = (AB) + (\overline{A+B}) = 1$

For input 01:
$AB = 0$, $\overline{A+B} = 0 \Rightarrow Q = 0$

For input 10:
$AB = 0$, $\overline{A+B} = 0 \Rightarrow Q = 0$

For input 11:
$AB = 1$, $\overline{A+B} = 0 \Rightarrow Q = 1$

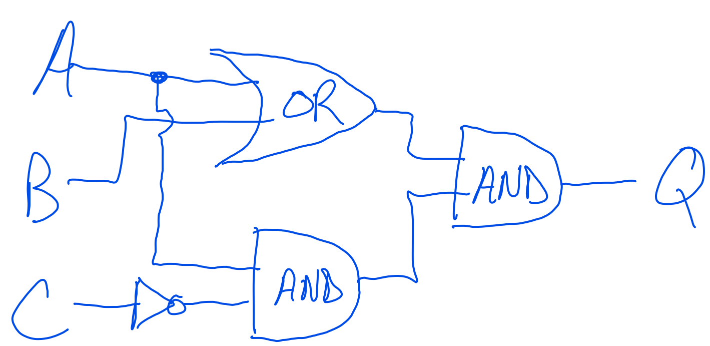
2. From the previous problem, what single logic gate has an equivalent truth table?

Looking at the slides that list out all of the 7 logic gates, the truth table in Problem 1 matches the XNOR truth table.

$\boxed{\text{XNOR}}$

3. Construct a truth table from the following Boolean expression, where '+' is OR and '∗' is AND.

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



A	B	C	Q
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	0

* Need $A = 1$ and $C = 0$ for $Q = 1$. Value of B doesn't matter.

4. Design a logic circuit using SOP (sum of products) that will implement a window detector for a three-bit input such that the output is HIGH when the input is between 3 and 5 inclusive.

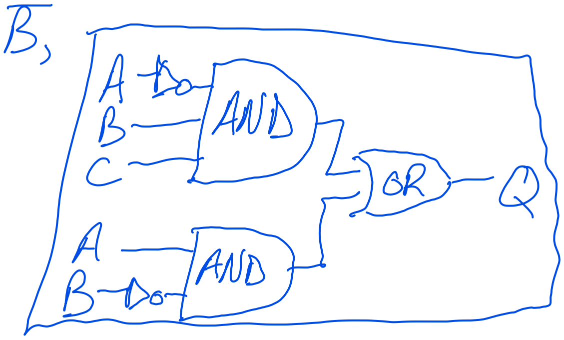
Dec	A	B	C	Q
0	0	0	0	0
1	0	0	1	0
2	0	1	0	0
3	0	1	1	1
4	1	0	0	1
5	1	0	1	1
6	1	1	0	0
7	1	1	1	0

$$Q = (\bar{A}BC) + \underbrace{(A\bar{B}\bar{C}) + (A\bar{B}C)}$$

- simplifying not required, but it makes for fewer logic gates -

Since $A\bar{B}(\cancel{\bar{C}+C}^{\,1}) = A\bar{B}$,

$\Rightarrow Q = \bar{A}BC + A\bar{B}$



5. Design a logic circuit using POS* (product of sums) that will implement a window detector for a three-bit input such that the output is HIGH when the input is between 2 and 6 inclusive.

Dec	A	B	C	Q
0	0	0	0	0
1	0	0	1	0
2	0	1	0	1
3	0	1	1	1
4	1	0	0	1
5	1	0	1	1
6	1	1	0	1
7	1	1	1	0

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

*POS steps:

- Find rows with a zero in the output
- Create a sum from the inputs on each row
- Complement inputs equal to one on a given row