Massimo Ginella

CS24 Elementary Computer Organization
Appendix A Exercises: A.1, A.3, A.5, A.7, A.17

$\boxed{\textbf{A.1}}$ [10] <A.2> In addition to the basic laws we discussed in this section, there are two important theorems, called DeMorgan's theorems:

$$\overline{A+B} = \overline{A} \times \overline{B} \text{ and } \overline{A \times B} = \overline{A} + \overline{B}$$

Prove DeMorgan's theorems with a truth table.

A	B	$\overline{A}$	$\overline{B}$	$\overline{A+B}$	$\overline{A} \times \overline{B}$	$\overline{A \times B}$	$\overline{A} + \overline{B}$
0	0	1	1	1	1	1	1
0	1	1	0	0	0	1	1
1	0	0	1	0	0	1	1
1	1	0	0	0	0	0	0

We can conclude that DeMorgan's theorems are correct given that the bit sequences for $\overline{A+B}$ are in fact equal to $\overline{A} \times \overline{B}$ and the bit sequences for $\overline{A \times B}$ are in fact equal to $\overline{A} + \overline{B}$

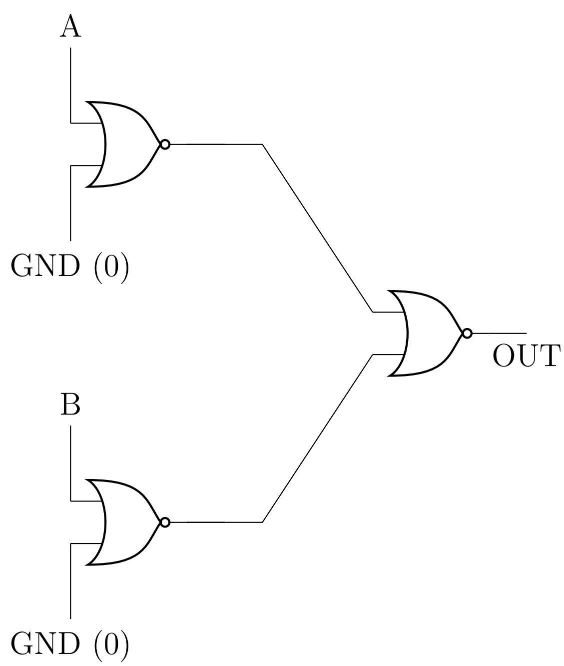
$\boxed{\textbf{A.3}}$ [10] <A.2> Show that there are 2^n entries in a truth table for a function with n inputs.

If you have a decoder, you **must** have 2^n outputs for every n inputs. The reason behind this is due to the fact that with n inputs, you can represent every base 10 number up until 2^n with a binary representation that is n bits long. In the context of a decoder, you can decode 2^n numbers with n single bit inputs.

A.5 [15] <A.2>Prove that the NOR gate is universal by showing how to build the AND, OR, and NOT functions using a two input NOR gate.

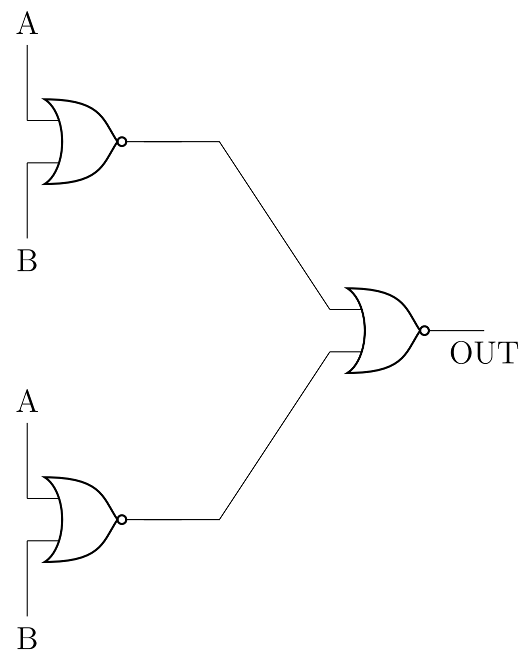
AND

A B	OUT
0 0	0
0 1	0
1 0	0
1 1	1



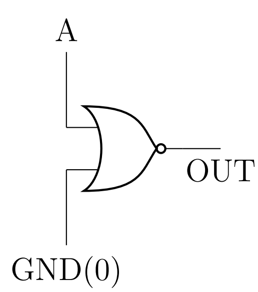
$\boxed{\text{OR}}$

A B	OUT
0 0	0
0 1	1
1 0	1
1 1	1



$\boxed{\text{NOT}}$

A	OUT
0	1
1	0



$\boxed{\textbf{A.7}}$ [10] <A.2, A.3>Construct the truth table for a four input odd parity function (see page A-65 for a description of parity)

A parity is defined as a count of 1's in a word. The word has odd parity if the number of 1's is odd. We will base our truth table off of this information.

A B C D	Odd Number of 1's?
0 0 0 0	0
0 0 0 1	1
0 0 1 0	1
0 0 1 1	0
0 1 0 0	1
0 1 0 1	0
0 1 1 0	0
0 1 1 1	1
1 0 0 0	1
1 0 0 1	0
1 0 1 0	0
1 0 1 1	1
1 1 0 0	0
1 1 0 1	1
1 1 1 0	1
1 1 1 1	0

A.17 [5] <A.2, A.3>Show a truth table for a multiplexor (inputs A, B, and S; output C), using don't cares to simplify the table where possible.

Assuming the 'on' channel for A is set to 0 and the 'on' channel for B is set to 1, we will have the following truth table for a two input (A and B), one selector (S), and one output (C), multiplexor:

S A B	C
0 0 0	0
0 0 1	0
0 1 0	1
0 1 1	1
1 0 0	0
1 0 1	1
1 1 0	0
1 1 1	1