|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Name** | **Gate Symbol** | **Boolean Algebra** | **Alternative Notation** | **Truth table** |
| AND | and | C=AB | C=A AND B | |  |  |  | | --- | --- | --- | | **A** | **B** | **A AND B** | | **0** | 0 | **0** | | **0** | 1 | **0** | | **1** | 0 | **0** | | **1** | 1 | **1** | |
| OR | or | C=A+B | C=A OR B | |  |  |  | | --- | --- | --- | | **A** | **B** | **A OR B** | | **0** | 0 | **0** | | **0** | 1 | **1** | | **1** | 0 | **1** | | **1** | 1 | **1** | |
| XOR | xor | C=A⊕B | C = A XOR B | |  |  |  | | --- | --- | --- | | **A** | **B** | **A XOR B** | | **0** | 0 | **0** | | **0** | 1 | **1** | | **1** | 0 | **1** | | **1** | 1 | **0** | |
| NOT | not | C=A | *C = NOT A = A’* | |  |  | | --- | --- | | **A** | **NOT A** | | **1** | **0** | | **0** | **1** | |
| NAND |  |  |  |  |
| NOR |  |  |  |  |

1. Show all identities, for example A + 0 = A

2. Show De Morgan’s laws both in boolean algebra and in logic gate diagrams.

3. Show a CMOS circuit implementing a NAND gate and a NOR gate. Be sure to identify each transistor whether it is a P-channel or N-channel device.  
You may copy a circuit from the internet, but you should find a clean one (not a low-resolution, blurry image if you want full points) and you must cite your source.  
  
+30% if you draw your own circuits in a CAD package.

4. Use the following power MOSFET as an example, obviously voltages are a lot lower in logic.  
<https://www.vishay.com/docs/91031/irf630.pdf>  
<https://www.vishay.com/docs/91084/irf9630.pdf>

In an N-channel MOSFET, set the gate to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in order to make the resistance \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.  
In an N-channel MOSFET, when the gate is 0V, the resistance is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.  
In a P-channel MOSFET, set the gate to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in order to make the resistance \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.  
  
The first transistors were bipolar junction transistors (BJT). These are still cheaper. Why are Field Effect Transistors (FETs) used to implement logic on computers?  
<https://en.wikipedia.org/wiki/MOSFET>  
<https://en.wikipedia.org/wiki/Bipolar_junction_transistor>

Explain why N-channel MOSFETS are preferred over P-channel where possible.

5. Create a table showing IEEE and international symbols for the following components:

a. resistor

b. capacity

c. inductor

d. NPN junction transistor

e. PNP junction transistor

f. N-channel MOSFET

g. P-channel MOSFET

6. Digital logic is an approximation, we write 0 and 1 representing \_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.  
A digital signal can switch on instantaneously. In reality a real signal cannot respond instantly because the circuit has a finite \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.