Logic Gates

1. Label the following logic gates:

2. Convert the following to boolean expressions:
   (a) NAND
   (b) XOR
   (c) XNOR

3. Create an AND gate using only NAND gates.

4. How many different two-input logic gates can there be? How many n-input logic gates?

Boolean Logic

1 + A = 1 \quad A + \overline{A} = 1 \quad A + AB = A \quad (A + B)(A + C) = A + BC

0B = 0 \quad BB = 0 \quad A + AB = A + B

DeMorgan’s Law: \overline{AB} = \overline{A} + \overline{B} \quad \overline{A + B} = \overline{A} \overline{B}

1. Minimize the following boolean expressions:
   (a) Standard: (A + B)(A + \overline{B})C

   (b) Grouping & Extra Terms: \overline{A \overline{B} C} + \overline{A B C} + A \overline{B} C + \overline{A B C} + A B C + A \overline{B} C

   (c) DeMorgan’s: \overline{A(BC + BC)}
State

1. Fill out the timing diagram for the circuit below:

```
+----+    +----+    +----+
IN--|D Q|--s0--|D Q|--s1--|D Q|--Out
     |    |    |    |
CLK----------------+
```

```
clk
in s0 s1 out
```

2. Fill out the timing diagram for the circuit below:

```
+----+    +----+
A--|D Q|--R1--|D Q|--R2--
     |    |    |
CLK----|>o--+
```

```
clk !clk A R1 R2
```

FSM

1. Fill in the following FSM for outputting a 1 whenever we have two repeating bits as the most recent bits, and a 0 otherwise. You may not need all states.

```
ocrates
1
```

```
Start
```

```
0
```