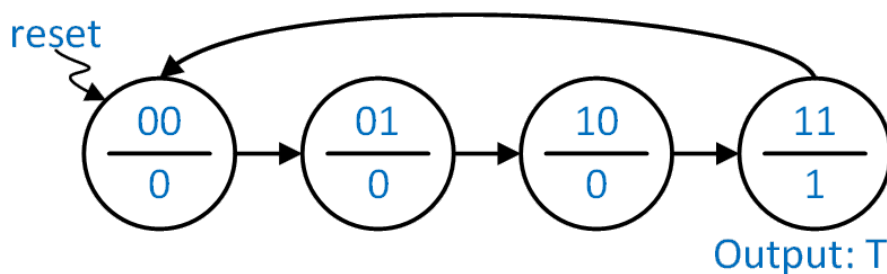


Reading: Finite State Machines

Read this after watching the videos for the week.

Sometimes the output of a state machine is not equal to the state.

For example, we might need to create a state machine that outputs a periodic signal that is equal to 1 one fourth of the time, and a 0 the rest of the time (i.e., has a 25% duty cycle). The state diagram for this machine, shown below, looks very similar to the state diagram for a 2-bit counter (which counts 0, 1, 2, 3). The main difference is that there is a horizontal line in each state circle, with the state value shown above the line, and the state machine's output value is shown below the line.



This state machine has four states, each uniquely identified by a 2-bit state number (shown above the line in each state). Since the state number requires 2 bits, the circuit that implements this state machine requires two flip-flops (one per bit of the state). The contents of the flip-flops indicate the current state of the machine. So if at some point in time both flip-flops are storing a 1, then the machine is in state **11**, and at the next positive clock edge 0s will be stored into both flip-flops to make the machine enter state **00**.

The legend for this state diagram tells us that the name of the output signal is **T**. The diagram indicates that signal **T** will be equal to 1 only in state **11**, and is equal to zero in all other states. Some state machines have more than one output. In that case, multiple signal values will appear below the line in each state.

A waveform for the behavior of this state machine is shown below. Notice that the state only changes at the positive clock edges because the state is the contents of the flip-flops, and the flip-flops can only store new values at the positive clock edges. During the points in time when the circuit is in states **00**, **01**, or **10**, the output signal **T** is equal to 0. However, whenever the circuit is currently in state **11**, the output signal **T** is equal to 1. As the waveform shows, this means that **T** is equal to 1 for one clock cycle out of every four clock cycles, which was the desired behavior for the state machine.

