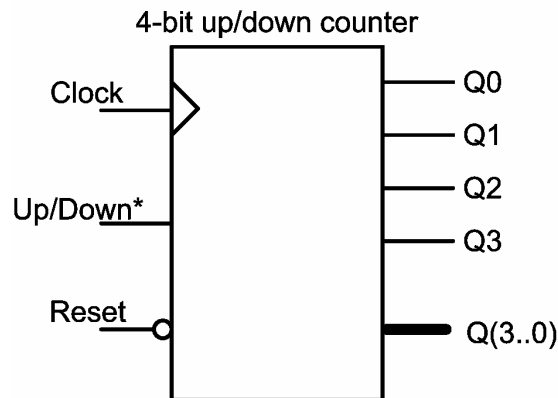


All the normal rules apply: Due next class, work on separate paper, start early, show your work, label everything (especially on graphs -including axes, time/voltage divisions, function plots, etc.), specify units, circle answers.

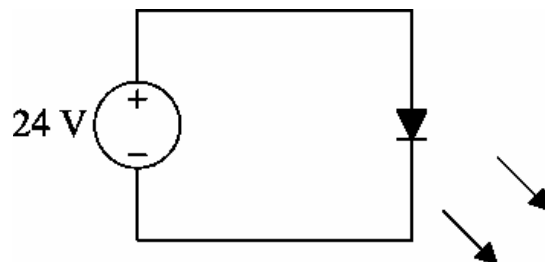
1. Create a timing diagram for the 4-bit counter shown below. Use graph paper, neatness will figure prominently in the grade for this problem.

On falling clock edges, the counter counts repeatedly in binary from 0000 up to 1111 (0 to F in hexadecimal) or from 1111 down to 0000, depending on the state of the Up/Down* and Reset input signals. Be careful to note whether your inputs are active high or active low. The Up/Down* name reads "Up, Down NOT" and signifies that the counter counts up when its input is in the active state, and down when it is not.

Assume your counter is initially outputting 0111. Draw your diagram such that the counter counts UP from 0111 to 0110 (rolling over from 1111 to 0000), and then back down to 0111 (the Up/Down* input line must be inverted to change counting direction). Once it has reached 0111, put your counter into a reset state for three clock pulses to end your timing diagram. Show the states of the Clock, Up/Down*, and Reset lines along the way. Your diagram should also show the individual binary bits (Q0, Q1, Q2, Q3) and hexadecimal notation for Q(3..0) in your output waveforms.



2. The light emitting diode (LED) in the following schematic is rated to operate at a nominal current of 15 mA. Modify the circuit such that the LED is operating at its rated current. In the new circuit, assume ideal conditions (the voltage drop across the LED is zero).



3. For the following schematic, assume the LEDs are operating at their rated currents. The clock signal is a standard 5 volt TTL pulse (square wave) with a frequency of 1 Hz. Use a table to list your answers.
- Assuming ideal conditions, describe the current flow and physical appearance of each LED while the TTL signal is LOW.
 - Assuming ideal conditions, describe the current flow and physical appearance of each LED while the TTL signal is HIGH.

