CS 250 Spring 2017 - Lab 03
Due in lab Feb. 07-10, 2017
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Questions

1. [15 points; 5 points for each for result] Does the timing of the 555 clock output match the predictions of the equations for frequency, t_high, and t_low that are given below the schematic? Show a calculation of the expected value for each of the three parameters..

   Frequency = $1/(\ln(2) * C2 * (R1 + 2 * R2)) =$
   = 1 / (ln(2) * 0.001F * (470Ω + 2 * 470Ω)) = **1.023 Hz**

   t_high = ln(2) * (R1 + R2) * C2
   = ln(2) * (470Ω + 470Ω) * 0.001F = **0.6516 seconds**

   t_low = ln(2) * R2 * C2
   = ln(2) * 470Ω * 0.001F = **0.3258 seconds**

2. [10 points] The 74HC163 is a 4-bit counter, but this lab needs only a 3-bit counter. How can you obtain a 3-bit counter from the output of a 4-bit counter? Which three of the output signals would you select and why?

   You can obtain a 3-bit counter from the output of a 4-bit counter by simply excluding the most significant bit. We would select the three output signals of the three least significant bits. This works because in a 4-bit sequence the 3 least significant bits just repeat (if ignoring the most significant bit), thus acting like a 3-bit counter.

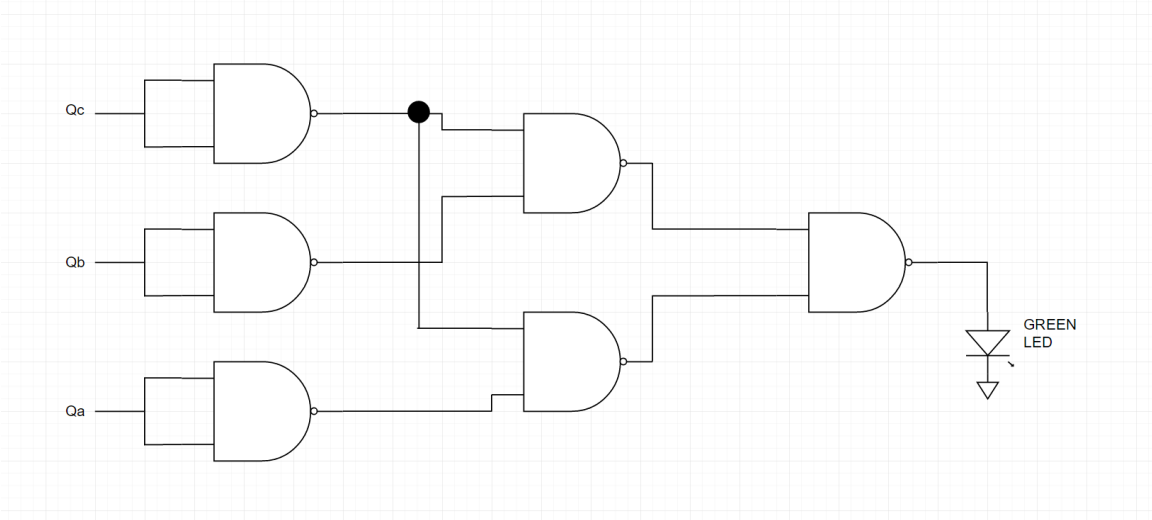
3. Derive the Boolean expressions for each color of the stoplight, and simplify in terms of 2-input NAND and NOR gates. Show your work to earn credit. Your Boolean expression must be in terms of QA, QB, QC, and QD, for the counter outputs, and/or D0 – D7 for the eight decoder/demux outputs. Draw the final schematic diagram using NAND and NOR gates for each color.

   a. [10 points] Green light Boolean expression and schematic.

Qc	Qb	Qa	Output
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	0

Qa \ Qc Qb	00	01	11	10
0	1	1	0	0
1	1	0	0	0

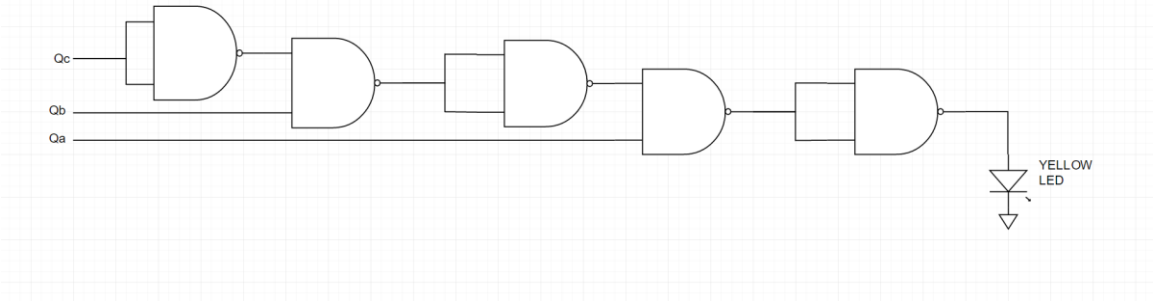
K-Map: Qc'Qb' + Qc'Qa'
NAND: ((Qc'Qb')' * (Qc'Qa')')'



b. [10 points] Yellow light Boolean expression and schematic.

Qc	Qb	Qa	Output
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	0

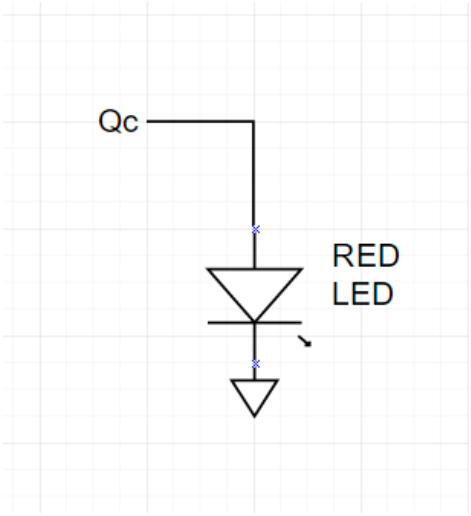
Qa \ Qc Qb	00	01	11	10
0	0	0	0	0
1	0	1	0	0



c. [10 points] Red light Boolean expression and schematic drawing of gates.

Qc	Qb	Qa	Output
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

Qa \ Qc Qb	00	01	11	10
0	0	0	1	1
1	0	0	1	1



4. Demonstrate your circuit to your TA. Full credit when the order and timing of lights is correct.
   a. [15 points] Green light turns on for 3 seconds, then
   b. [15 points] Yellow light turns on for 1 second, then
   c. [15 points] Red light turns on for 4 seconds.