Computer Science 281
Lab 5: Creating a Multiplexor

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1 Two input multiplexors

A *multiplexor* is a combinational logic device that uses control bits to select from a set of inputs. The simplest two-input multiplexor has inputs bits A and B, and a single selector bit, s. When the selector bit s is 0, the output Q of the multiplexor is the value of A. When the selector bit s is 1, the output Q of the multiplexor is the value of B.

We can generalize the two-input multiplexor so that A and B each consist of multiple bits. In a three-bit, two input multiplexor, $A = a_2a_1a_0$ and $B = b_2b_1b_0$, and the output $Q = q_2q_1q_0$. Because there are still just two (multi-bit) inputs, we still just need a single selector input bit s. When s is 0, then q_2 takes on the value of a_2, q_1 takes on the value of of a_1 and q_0 takes on the value of a_0. Similarly when s is 1, the bits of Q take on the values of B.

Your goal is to build a three-bit, two input multiplexor. This circuit will have 7 bits of input and three bits of output. We start by designing the single bit, two-input multiplexor and then create three of these. The input bits of A and B are wired to the single input bits of the individual multiplexors, and the single selector bit s is wired to all three individual multiplexors.

Perform the following for the single bit two-input multiplexor:

1. Build the truth table.
2. Generate a K-map for the Q output.
3. Give a boolean expression for Q.
4. Draw a circuit diagram for the single bit two-input multiplexor.

Create the *three bit two-input multiplexor* on the breadboard, and then demonstrate the completed circuit for your instructor.

2 Generalizing to more inputs

We can also generalize the multiplexor by giving it more than two inputs. In general, a multiplexor can have n inputs, $A_0, A_1, A_2, \ldots, A_{n-1}$, and still have a single output Q. The selector, S, would need to select one of the n inputs to "route" to the output. To do this, S must consist of enough bits to represent n values. The bits of S would correspond to the number of the input to be directed to the output. So, for example, if we were to design a four input multiplexor, with inputs A_0, A_1, A_2, A_3, we would need a selector $S = s_1s_0$ where a pattern of 00 would select input A_0, 01 would select input A_1, 10 would select input A_2, and 11 would select input A_3. In general, it takes $\log_2 n$ selector bits to select from n inputs (when n is a power of 2).

Using the single-bit two input multiplexor as a building block (3 input bits, one output bit), design a circuit for the single-bit four input multiplexor (6 input bits, one output bit). Hint: It can be done with three single-bit two input multiplexors.

Demonstrate your completed circuit for your instructor.