Digital Logic: Lab Report

1. Draw the layout of the 4-inverter chain using the Quad NAND IC. Show the actual physical layout of the circuit – "top view" – on the breadboard. Also show the internal wiring of the breadboard.

2. Construct the inverter chain, using a wire to apply either Vdd=5V=logic 1 or Vss=0V=logic 0 to the chain input. Using the scope, verify the logic states within the chain. Repeat for Vdd=2V. Next, setup the function generator to provide a 1kHz square wave to the input and verify the switching of all the inverters in the chain.

3. Set the function generator to input a 1kHz square. Measure the gate delays through 1,2,3,4 gates at Vdd=5V, then Vdd=2V. Be sure to set the function generator VPP and VDC for different Vdd. To switch between HL and LH transitions, switch the trigger edge direction. For convenience, set Time Ref to Left.

Vdd=5V	**1 gate**	**2 gates**	**3 gates**	**4 gates**
t_{pHL}, Output				
t_{pLH}, Output				
Average t_{pavg}				

Vdd=2V	**1 gate**	**2 gates**	**3 gates**	**4 gates**
t_{pHL}, Output				
t_{pLH}, Output				
Average t_{pavg}				

Based on the average of the difference between 1 and 3 gates (two gate delays) what is the average gate delay at each of the Vdd supply voltages? (Note: we do not want to use measurements from the last gate since it is not loaded by any other logic gate input).
Avg Gate Delay =_______ at Vdd=5V; Avg Gate Delay =_________ at Vdd=2V.

4. Verify the static logic for the XOR circuit by wiring inputs to logic high (Vdd) or low (Vss=0V) and using the scope to view the output.

Verify Vdd=5V Static Logic			**Verify Vdd=2V Static Logic**		
A	**B**	**Output**	**A**	**B**	**Output**
0	**0**		**0**	**0**	
0	**1**		**0**	**1**	
1	**0**		**1**	**0**	
1	**1**		**1**	**1**	

7. Now use the square wave input on input A and measure propagation delay for the XOR. Make sure to adjust the square wave to match the Vdd voltage levels. How do these delay times compare with the inverter gate delays?

Set Vdd=5V, wire B=0, then measure delay: from A(0 to 1) to Output =
from A(1 to 0) to Output =

Now wire A=1, then measure delay: from B(0 to 1) to Output =
from B(1 to 0) to Output=

Set Vdd=2V, wire B=0, measure delay: from A(0 to 1) to Output =
from A(1 to 0) to Output =

Now wire A=1, then measure delay: from B(0 to 1) to Output =
from B(1 to 0) to Output=

More fun: Try setting up the Oscilloscope as a Digital Logic Analyzer for measuring gate delay and comment.

More fun: Calculate the series resistor to use in the LED logic probe (LLP) for I_{diode}=5mA and construct the LLP using the power supply Vdd as a logic "1". What color LED do you have (this affects V_{diode})? Note the change in LED brightness between Vdd=5V and 2V.