ELEC 313 Lab 5
CMOS Circuits

REFERENCE: 1. Microelectronic Circuits, Sedra & Smith, Oxford University Press, Chapter 13
2. Fundamentals of Logic Design, Roth & Kinney, Cengage, Appendix A

OBJECTIVE: The objective of this experiment is to construct and observe the operation of a CMOS inverter and NAND gate.

EQUIPMENT: ALD1105 Dual N-channel and Dual P- channel matched pair MOSFET
Power Supply (Vdc)
Function Generator
Oscilloscope

PRIOR PREPARATION (Pre-Lab):

1. Download and review the specification sheet for the ALD1105 Dual N and P channel matched pair MOSFET.
2. Using your text or other resources review the circuit operation of CMOS Inverter and NAND gate circuits similar to those of figure 1 and figure 2.
3. Annotate a copy of both figure 1 and figure 2 with the appropriate pin numbers from the ALD1105 spec sheet, and place in your lab notebook.
4. Create a truth table for the expected outputs of the NAND gate.

EXPERIMENT

The following procedure will be used to evaluate the CMOS inverter.

1) Construct the circuit of figure 1.
2) Connect the V^+ terminal (Pin 11) to the + supply voltage.
3) Connect the V- terminal (Pin 4) to the circuit ground.
4) Set V_{DD} to 5 volts using the HP source.
5) Use the function generator for input v_i. Set the function generator to a frequency of 20 kHz and select a triangle wave. Set the wave for 0 to 5 volts using the offset.
6) Connect CHANNEL 1 of the oscilloscope to the input and CHANNEL 2 to the output.
7) Use the x-y plot function of the scope to produce the transfer characteristic v_o vs. v_i. (Press the main key, then the *xy* softkey, then adjust the voltage scales as needed.)
8) Capture the v_o vs. v_i data, so you can recreate the plot for the lab report.
9) Adjust the amplitude and offset of the function generator for an input square wave of 0 to 5 V *as measured on the oscilloscope*.
10) Adjust the scope and capture both input and output on one screen for the report.
11) Measure the propagation delay times of the output waveform.

The following procedure will be used to evaluate the CMOS NAND gate.

1) Construct the circuit of figure 2.
2) Connect the V^+ terminal (Pin 11) to the + supply voltage.
3) Connect the V- terminal (Pin 4) to the circuit ground.
4) Set the + supply voltage to 5 volts DC using the HP source.

5) Set input A to 0 volts.
6) Use the function generator for input B. Set the function generator to a frequency of 20 kHz and select a square wave. Set the square wave for 0 to 5 volts using the offset.
7) Connect CHANNEL 1 of the oscilloscope to the input and CHANNEL 2 to the output.
8) Adjust the scope and capture both input and output on one screen for the report.
9) Repeat step 8 with input A set to +5 volts.

LAB REPORT

Your report should be completed in the format requested by the instructor. The lab report should be in standard format and include the following additional items:
1) Using the transfer characteristic for the inverter, explain the circuit operation.
2) Discuss the operation of the NAND gate circuit and explain how it achieves its truth table.
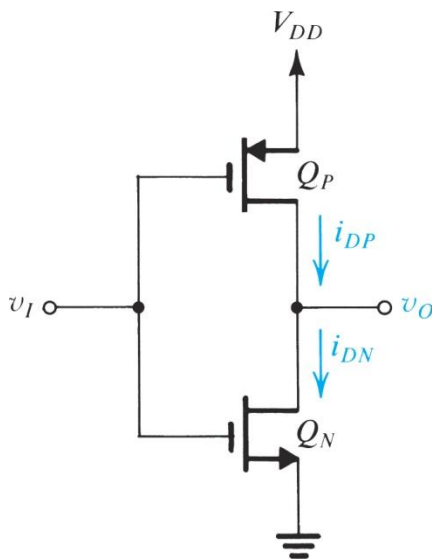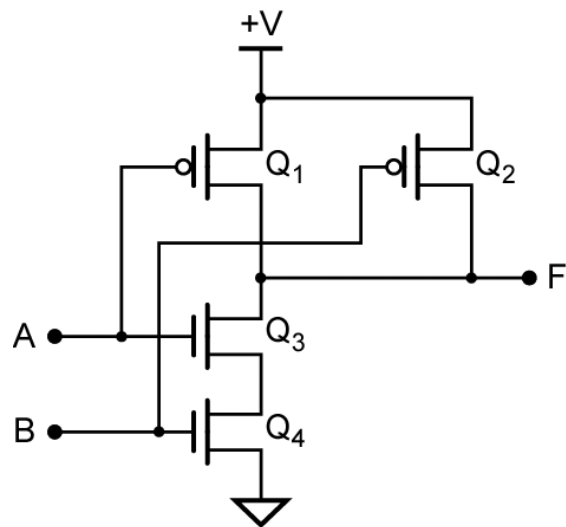3) Discuss how the screen capture relates to the truth tables for the NAND gate circuit.

Figure 1: CMOS Inverter.

Figure 2: CMOS NAND Gate.