UNIVERSITY OF MANITOBA
Department of Electrical and Computer Engineering

Name: _____

Student Number: _____ **Date:**

Lab Section: _____

Instructor: _____

Lab Partner: _____

ENG 1450 Introduction to Electrical and Computer Engineering

Lab 7 – Digital Signals & Comparators

The equipment required for this lab exercise includes:

- a project board with with a 5 V supply
- two Digital Multimeters (DMM)
- a 7404 Hex Inverter gate chip
- a 741 op-amp chip
- Oscilliscope
- Function generator

Consider the following digital circuit, where, unlike the previous lab, a signal (not a constant voltage) is applied as the input of a NOT gate.

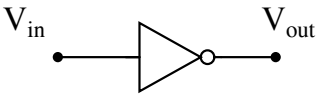
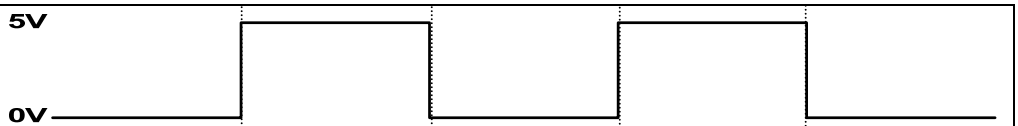


Figure 1: A NOT gate.

Using the function generator, apply a 1 kHz 0-5V square wave as the input, V_{in}. plot the output voltage in Table 1. Explain the result.

Table 1

V_{in}	
V_{out}	

Now, repeat this experiment for the following circuit and complete Table 2.

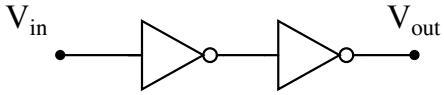


Figure 2: Two cascaded NOT gates.

Table 2

V_{in}	5V 0V
V_{out}	

Discuss the output waveform.

Question: If a large, even number of NOT gates are cascaded, would the input and output waveforms be exactly the same?

We now repeat the first experiment, except that the input waveform is now a sine wave (sinusoid).

Complete Table 3 by applying a sine wave as the input to the NOT gate shown in Figure 1. Plot and discuss the output waveform.

Table 3

V_{in}	5 V 0 V
V_{out}	

In this part of the lab, we will investigate the operation of an op-amp in the open-loop mode used as a comparator. In this mode of operation, the output voltage is either at the positive saturation voltage (almost equal to the positive power supply) or at the negative saturation voltage (almost equal to the negative power supply). Figure 3 shows the schematic diagram of op-amp 741.

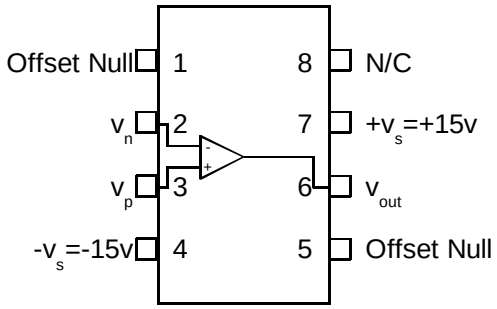


Figure 3: Pin-out diagram of the 741 integrated circuit op-amp

If V_p (pin 3) is slightly greater than V_n (pin 2), then the output (pin 6) is almost equal to the positive power supply (pin 7). If V_n (pin 2) is slightly greater than V_p (pin 3), then the output (pin 6) is almost equal to the negative power supply (pin 4). To see how an op-amp works in the open-loop mode build the circuit shown below.

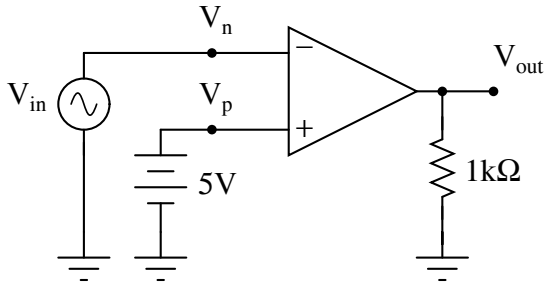
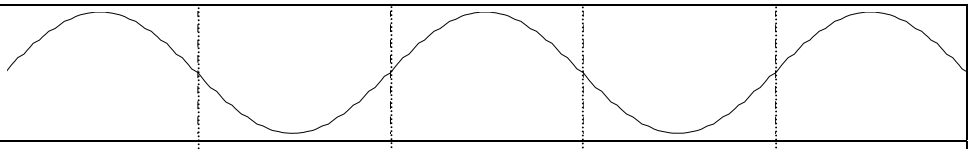


Figure 4: Comparator circuit

In this circuit, V_{in} is a 0-7 V sine wave from the function generator, and the 5-V dc source is provided by the project board.

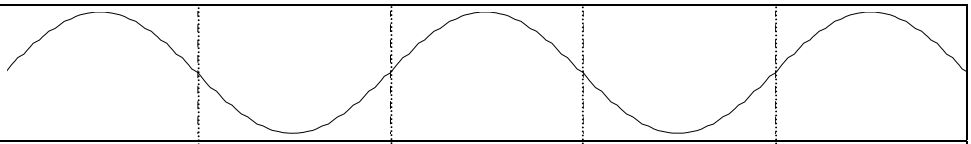
Plot V_{out} in Table 4 and explain the result.

Table 4

V_{in}	
V_{out}	

Swap V_{in} and the 5-V dc source. Plot V_{out} in Table 5 and explain the result.

Table 5

V_{in}	
V_{out}	

Show all of your results to the TA.

To be signed by the TA