Using Digital Works

Lab L02

Introduction:

Using Digital Works, you will construct and test two different logic circuits listed below. The purpose is to demonstrate that both circuits perform the same **XOR** function. **XOR** requires two source operands and returns a single output as indicated by the truth table below.

A	B	XOR
0	0	0
0	1	1
1	0	1
1	1	0

You will use the **AND**, the **OR** and the **NOT** functions (called gates) to construct the circuit.. Please note that the **NOT** gate is often also called an Inverter. These gates can represent by use of standard symbols listed below standard symbols, as shown in Figure 2a. In all cases the symbols are drawn with the inputs from the left and the output towards the right.

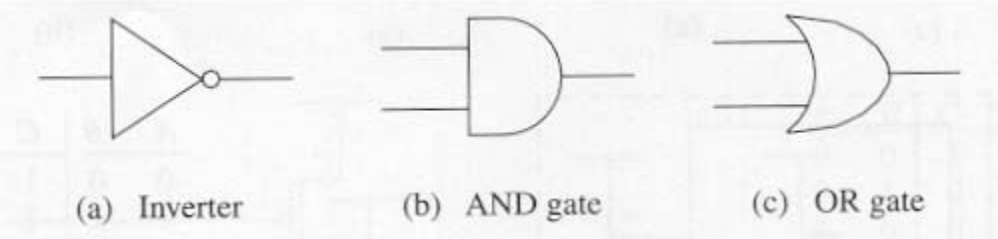

Figure 2a: **AND**, **OR**, and **NOT** gates

The **XOR** function can be implemented with two Inverters, two **AND** gates, and an **OR** gate, by connecting them as shown in Figure 2b.

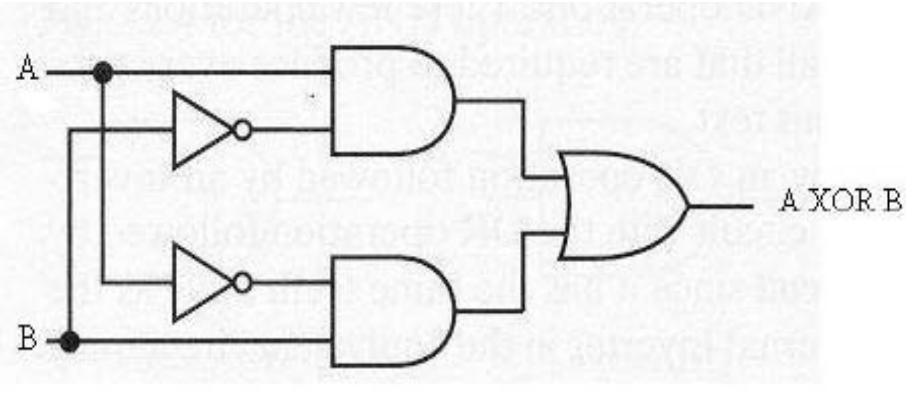

Figure 2b – XOR Circuit

Another way of implementing the **XOR** function is by connecting two inverters, two **OR** gates, and an **AND** gate, as shown in Figure 2c.

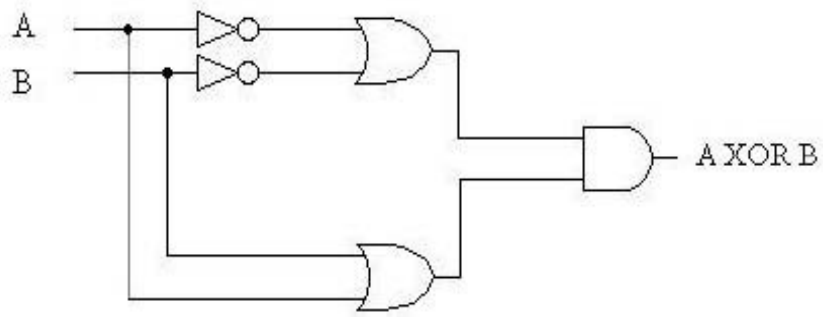

Figure 2c – XOR Circuit

You will demonstrate that both circuits perform the same function.

Creating the circuits:

After running Digital Works on your computer, you will get the initial screen shown in Figure 2d. We have annotated six of the most important icons on the toolbars. A circuit is constructed by using the mouse to place gates on the screen or workspace, and a 'wiring tool' to connect the gates together.

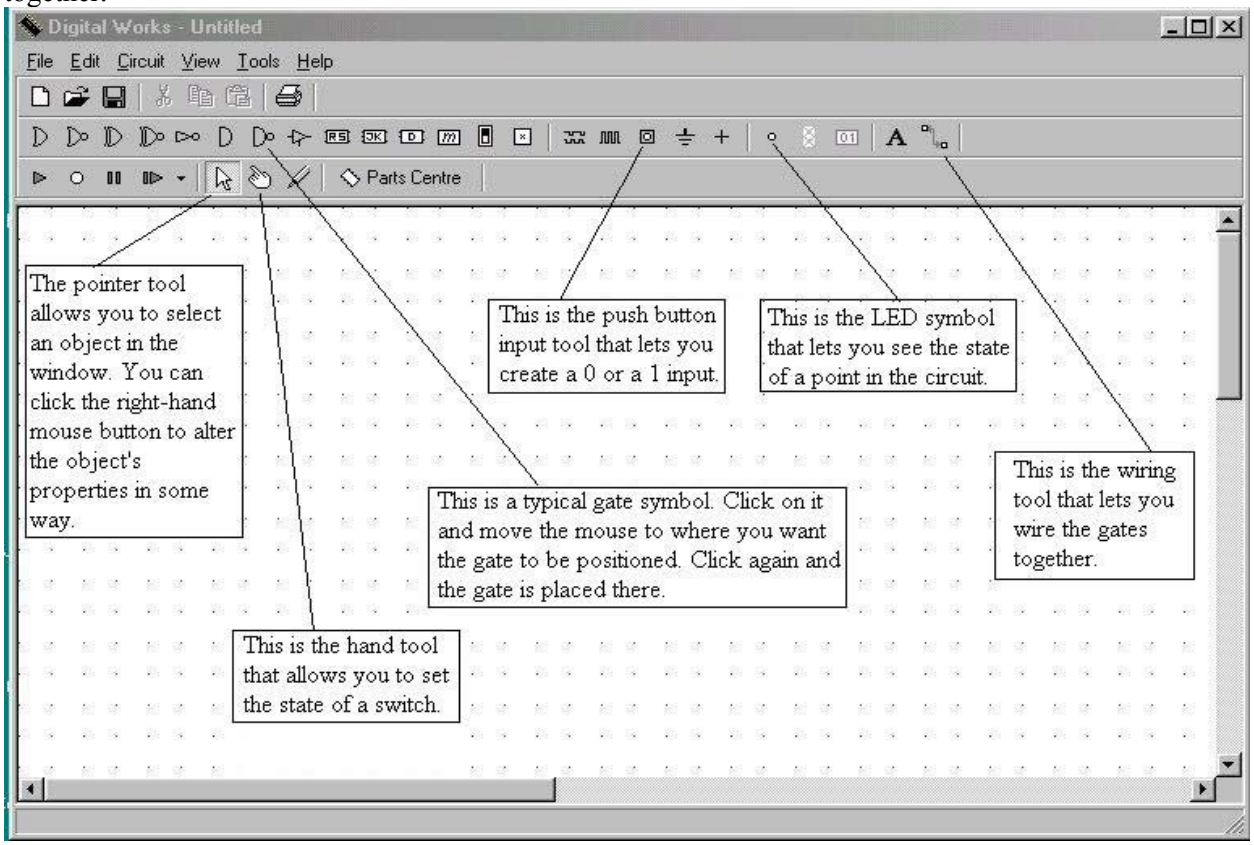

Figure 2d: Digital Works - the initial screen

Start by constructing the circuit shown Figure 2b. by planting two **AND** gates, an **OR** gate, and two inverters on the work area. To do this, first click on the pointer tool on the bottom row of icons, select a gate from the list on the second row of icons by left clicking on the gate with the pointer tool, move to a suitable location in the workspace and left clicking. Do this each of the 3 gates and the both inverters. Once the gates have been placed, you can tidy up the circuit by moving the gates within the work area to create a symmetrical layout. This can be done by select them one at a time with the mouse and dragging the gate wherever you want.

Before continuing, save the circuit. Click on the **File** function in the toolbar to bring down the menu, then select **Save**. You should now see a Save Circuit window. Enter LastnameF_L02a (where Lastname is your last name and F is you first initial.) as the name of your file. Digital Works inserts the extension **.dwm** as the file type. Enter an appropriate location for your file. Click **Save** to save the file.

The next step is to wire up the gates to create a circuit. First select the wiring tool from the toolbar. Then position the cursor over the point at which you wish to connect a wire. The cursor changes to **wire** when it's over a point that can legally be connected to. Left click to attach a wire and move the cursor to the point you wish to connect. Left click to create a connection. Instead of making a direct connection between two points, you can click on the workspace to create a node (i.e. the connection is a series of straight lines). You can make the wiring look neat by clicking on intermediate points to create a signal path made up of a series of straight-line segments. If you right click on a wire you can delete it. Your circuit should now look like as shown in Figure 2e.

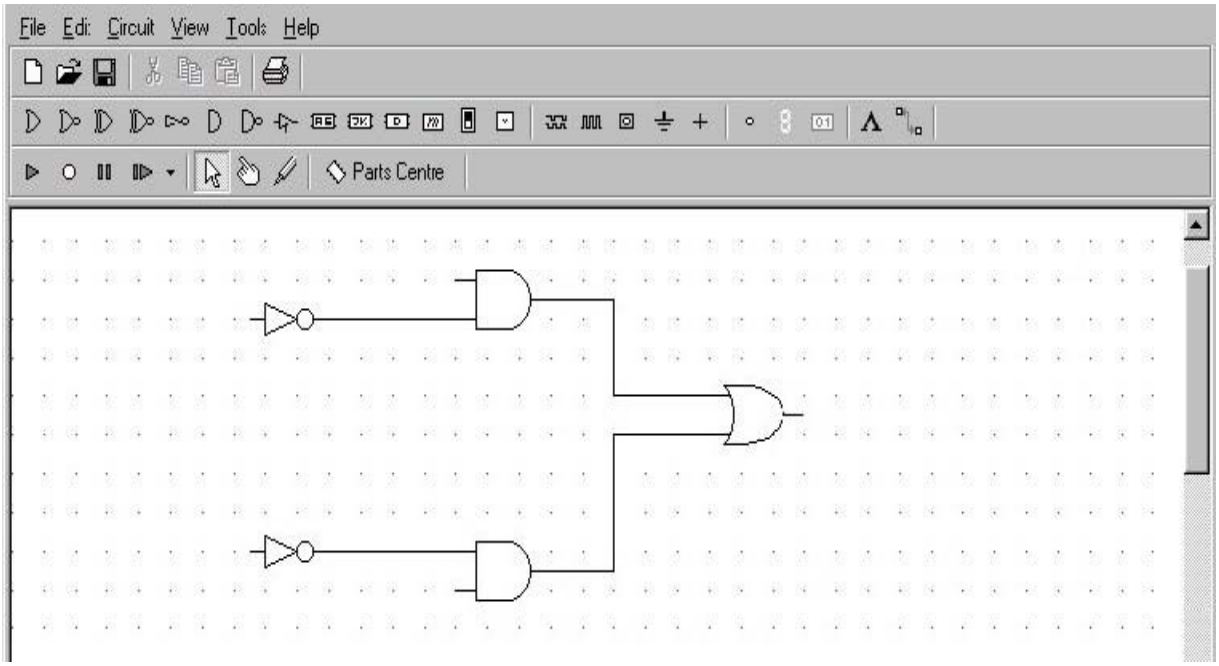

Figure 2e: Wiring gates together

Digital Works permits a wire to be connected only between two legal connections. In Figure 2e the inputs to the two inverters and the output of the **OR** gate aren't connected anywhere. In order to wire up the inputs and output we need points you can connect the wire to. In this case you are going to use the interactive input device to provide an input signal from a push button and the **LED** to show the state of the output. You will also record the output of the two **AND** gates, so you will have to connect their outputs to **LED**s as well. You should add inputs and **LED**s to the circuit and complete the rest of the wiring, as shown in Figure 2f.

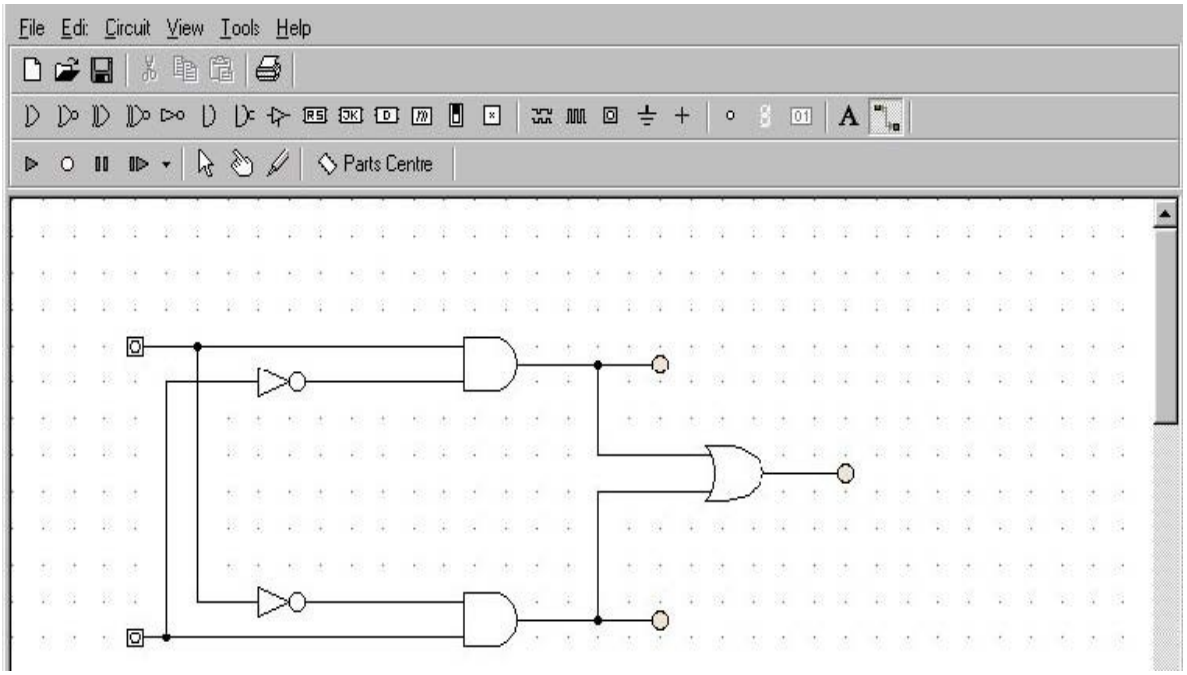

Fig. 2f: Completing the circuit

At this stage you could run the circuit if we wanted. However, you will use the text tool (indicated by the letter **A** on the middle toolbar) to give the circuit a title. Click on the **A** and then click on the place at which you wish to add the text to open the text window. This brings down a text box. Enter the text "**XOR circuit**" and click **Ok** to place it on the screen. We also wish to label the circuit's inputs and outputs. To give a name to an input or output, first select it and then right click to bring down a menu. You enter the name into the text box and click **Ok**. Figure 2g shows the circuit where the inputs and outputs have been labeled with names. Also make sure that you include at the top of the diagram, your name, the assignment number and the date.

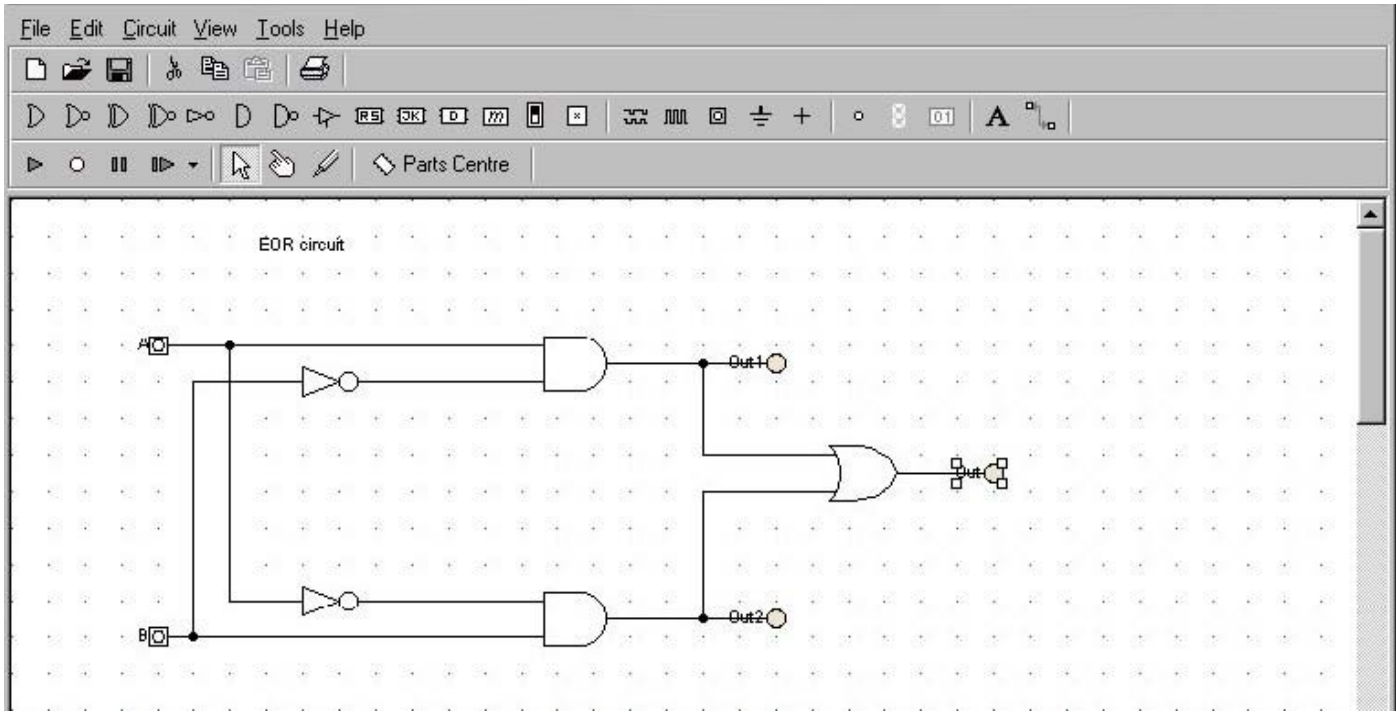

Figure 2g: Labeling the circuit and inputs and outputs

You can similarly construct the circuit shown in Figure 2c. This circuit requires two inverters, two **OR** gates, and one **AND** gate. Save this circuit in a file named LastnameF_L02b. Since you will not record the outputs of the two **OR** gates you do not need to connect them to **LED**s. You still need to add the two inputs, and connect the output of the **AND** gate to an **LED**. Do not forget to all the proper labeling just as you did in the previous diagram.

Running a simulation

You are now ready to begin simulation. The bottom row of icons is concerned with running the simulation. The leftmost icon is left clicked to begin the simulation. The next step is to change the state of the interactive input devices. If you click on the hand tool icon, the cursor changes to a hand when positioned anywhere over the work area. By putting the hand cursor over one of the input devices, you can left click the mouse to change the status of the input (i.e. input 0 or input 1). When the input device supplying a 1, it becomes red. You can change the states of the input devices to generate all possible input values for **A** and **B** and record the state of the output **LED**s.

Submitting Results

Complete the following table for each of the circuits. Validate that they produced the same results. Email the completed tables as well as both diagrams. Make sure that you have included you r name, date and the Lab assignment number the documents and Digital Works macros.

		Outputs		
A	**B**	**Out**	**Out1**	**Out2**
0	**0**	**0**		
0	**1**	**1**		
1	**0**	**1**		
1	**1**	**0**		