EE 112 23 February 2015

Lab Project 4 Report due 16 March 2015

DIGITAL LOGIC CIRCUIT SIMULATION USING MULTISIM

PURPOSE :

The purpose of this experiment is to introduce the student to a Computer Aided Design package that has a simulation tool, Multisim, that will allow the student to design and test the performance of digital circuits without actually building the hardware circuits.

The first part of the lab is to become familiar with the design tool by inputting several digital logic circuits and running the simulation, that is, to operate the circuits, and measure both the static and dynamic characteristics of the circuit. The static characteristics will be the functional operation of the circuit. The dynamic characteristics will be what we think of as the time varying characteristics.

The second part of the lab is to use this CAD tool for a couple of design purposes. One is to use the tool to measure the characteristics of a design, generating a truth table and then by applying Karnaugh Mapping, create a less expensive design, and then verify the performance of the new, more efficient design.

The third part of the lab is to use the design tool to design and eliminate a hazard from a circuit that we investigated in Lab 3. The elimination of the Hazard can be verified with the simulation tool.

PRE-LAB:

This Lab requires some preparation out of lab to minimize the time in lab. The prelab is to skim the Multisim Users Guide. Chapter 2 is the Multisim Tutorial and describes the Multisim Interface, schematic capture, simulation and a few other topics. The Users Guide is referred to in the Reference Material section of Blackboard Course Materials. Please make an effort to look through the Guide.

I realize that until you start using the tool in the lab, you will not have a good appreciation for this tool. But by looking at the Users Guide before class, at least you will know were some of the information is.

GENERAL LAB WRITE-UP INSTRUCTIONS:

As with the previous labs, you will be required to document your work, write a lab report, and answer questions related to the project. I will expect one lab report from each group.

Provide data as required and written answers to the questions. Due date for the reports is March 16th.

PROCEDURE

1) MODEL THE CIRCUITS IN FIGURES 1 & 2:

In this part of this lab, you are to model the circuit and measure both the static and the dynamic behavior of the circuits and observe the difference in performance.

For the circuit diagrams shown in Figures 1 and 2, build and demonstrate the performance of the circuits. For the functional performance and generation of the truth table, use switch models as the input to the circuits and an LED model as the output. Then sketch the truth table as the switches are thrown.

In Figure 1 & 2, there are 5 variables so the truth table addresses 5 variables ($2^5 = 32$ entries)

For the timing investigation, use the function generator model as the signal input and the model of the oscilloscope to observe the output of the circuit as one of the input signals is varied. From the truth table, select the conditions on the inputs that would result in a changing output as X1 is toggled by the function generator.

Then, using a Karnaugh Map, determine if there is a lower cost solution to come up with the same truth table.

As part of the write-up, answer the following questions:

1) For the circuits in Figure 1 and 2, sketch the truth tables and timing diagrams that you observed.

2) Is it possible to reduce the cost of either of the circuits? Be quantitative in your description of the reduction if it is possible.

2) USE THE SIMULATION TOOL TO HELP ANALYZE A CIRCUIT:

In this part of this lab, you are to model the circuit and measure both the static and the dynamic behavior of the circuits shown in figures 3 and 4. and observe the difference in performance.

For the circuit diagrams shown in Figures 3 and 4, model and investigate the performance of the circuits. Evaluate the functional performance and generate the truth table, using switch models as the input to the circuits and an LED model as the output. Then sketch the truth table as the switches are thrown.

For the timing investigation, use the function generator model as the signal input for X2 and observe on the model of the oscilloscope, the input and output of the circuit as the input signal, X2, is varied. (Keep in mind that X2 is the function generator output). Select the other inputs so that the output changes state as X2 is toggled.

Then, using a Karnaugh Map, determine if there is a lower cost solution to come up with the same truth table. Model the lower cost solution and verify with a truth table that the lower cost model exhibits the same performance.

As part of the write-up, answer the following questions:

1) For the circuits in Figure 3 and 4, sketch the truth tables and timing diagrams that you observed.

2) Is it possible to reduce the cost of either of the circuits? Be quantitative in our assessment, that is, if it can be reduced, by how much. Comment on any other factors such as hazards, number of parts, etc.

3) Determine the minimal sum-of-products expression for each of the figures (3 & 4).

3) USE THE SIMULATION TOOL TO HELP ELIMINATE A HAZARD IN A CIRCUIT:

In this part of this lab, you are to model the circuit and measure both the static and the dynamic behavior of the circuits shown in figures 5 anc 6. and observe the difference in performance.

For the circuit diagrams shown in Figures 5 and 6, model and investigate the performance of the circuits. Evaluate the functional performance of each of the circuits and generate the truth table for each circuit. Again, as in the previous experiments, use switch models as the input to the circuits and an LED model as the output to evaluate the functional performance. Then sketch the truth table as the switches are thrown.

To observe the Hazard requires you to investigate the timing of the circuit. Using the function generator model as the signal input for each of the inputs, observe on the oscilloscope, the input and output of the circuit as the input signal from the function generator is applied to the various inputs.

1) Determine the sum-of-products expression for each of the figures (5 & 6).

2) Using a Karnaugh Map, determine what fix is necessary to eliminate the hazard.

3) Is it a lower cost solutions? As mentioned earlier, be quantitative in your assessment.

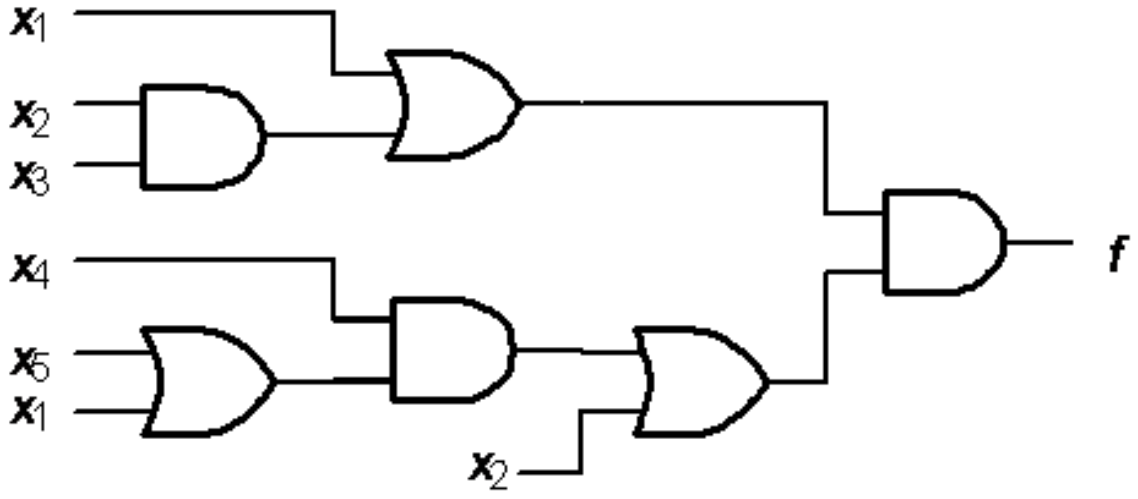


Figure 1

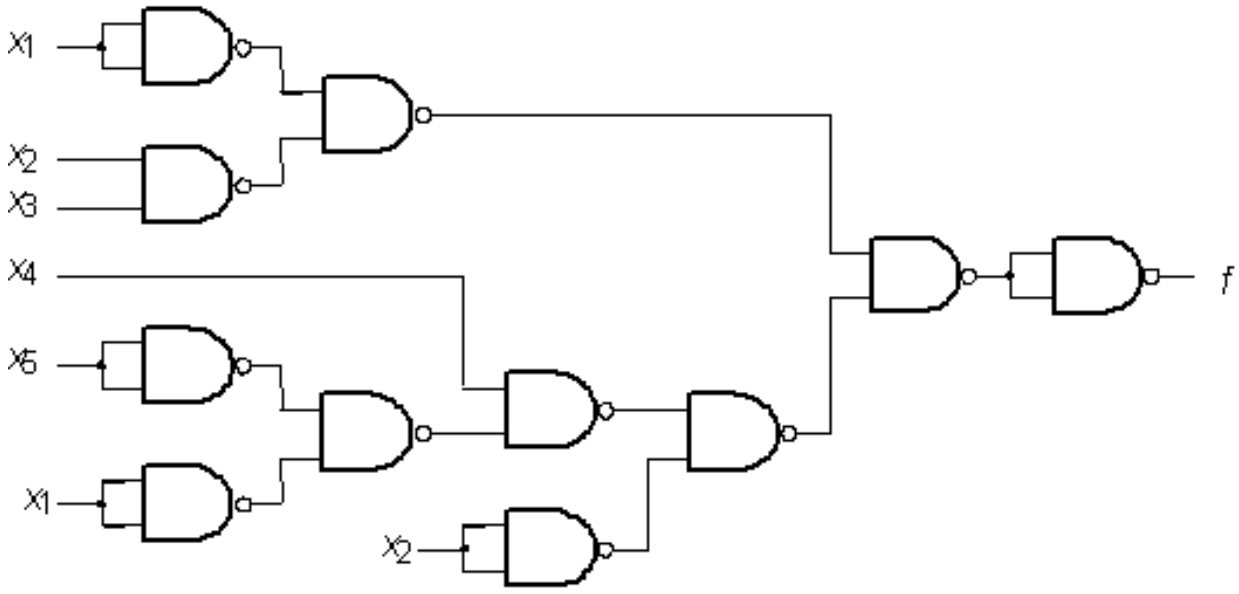
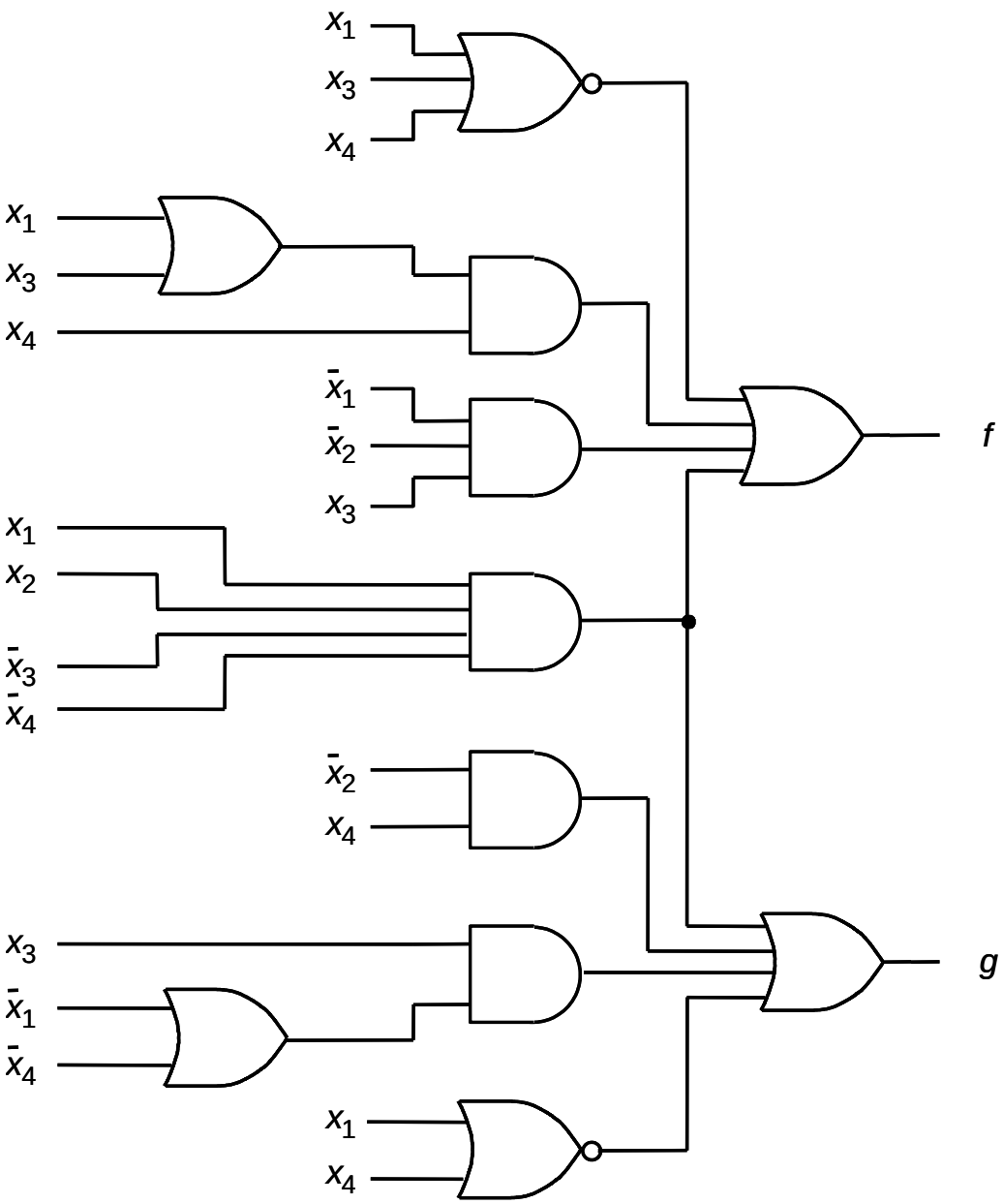


Figure 2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x_3
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FIGURE 3

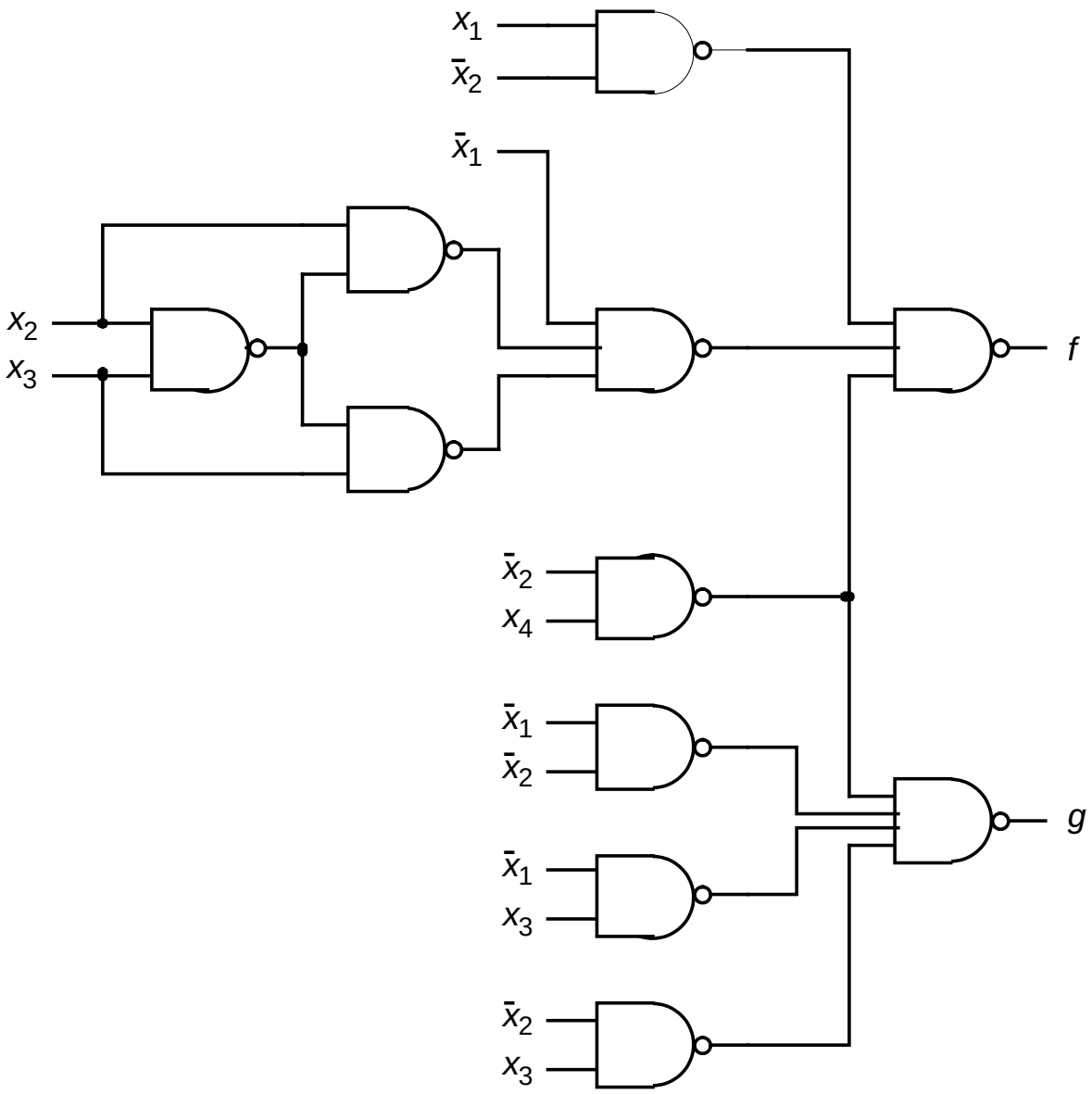

FIGURE 4

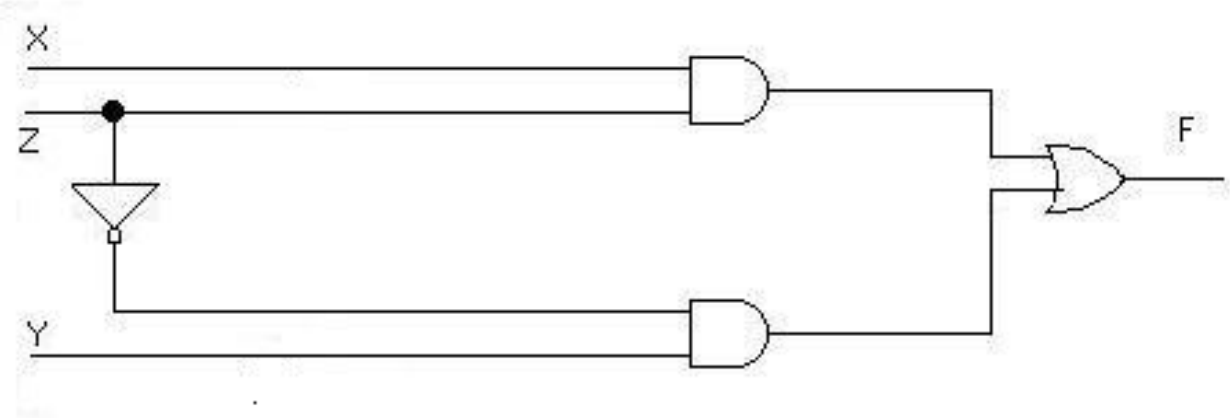

FIGURE 5

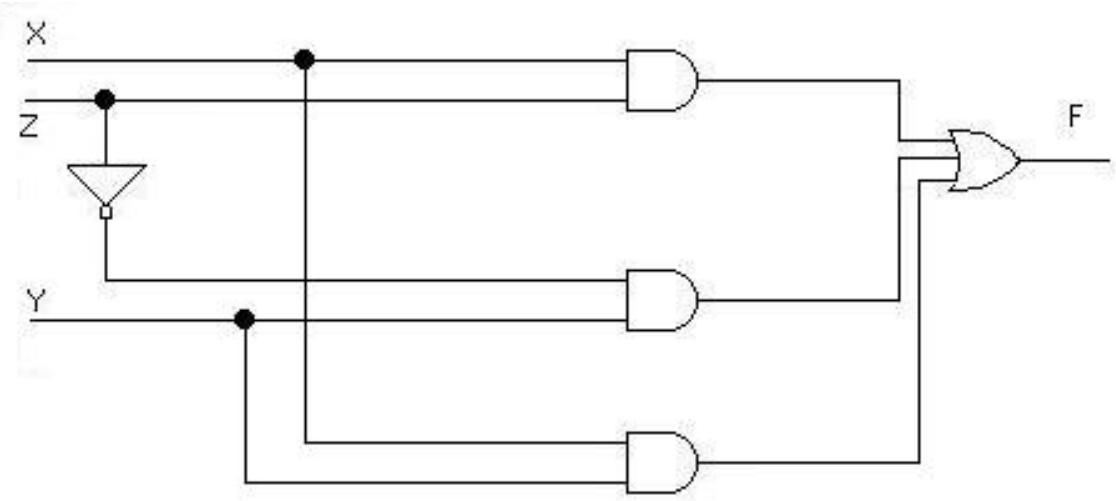

FIGURE 6