Middle East Technical University | Department of Computer Engineering

CENG 232

Logic Design

Spring '2015-2016

Lab 2

Due date: 25 March 2016, 23:55

1 Introduction

In this laboratory, you are expected to design a circuit for the problem given in Section 3, using the Logisim tool with the gates specified in Section 2. You are also required to implement your circuit physically in the lab as explained in Section 5.

2 IC Pool

- 74LS00
- 74LS02
- 74LS04
- 74LS08
- 74LS32
- 74LS153

3 Lab Work

In this lab, you are expected to design a circuit that checks divisibility without remainder. Requirements are given as follows:

- You will be given a 6-bit number as input in binary format which consists of two parts.
- Each input digit can take either 0 or 1.
- The first part of the input is a 2-bit number which is used for selecting the tasks explained in the "Tasks" sub-section.
- Each input digit in the first part should be labelled as S0, S1 where S0 is the least significant digit and S1 is the most significant digit.

- The second part of the input is a 4-bit number which represents decimal numbers between 0-15.
- Each input digit in the second part should be labelled as X0, X1, X2, X3 where X0 is the least significant digit and X3 is the most significant digit.
- Your output is a 1-bit number which should be labelled as Y which can take either 0 or 1.
- Y shows whether the task specified by S0 and S1 is satisfied or not.
- If the specified task is satisfied, Y is 1; otherwise, Y is 0.

3.1 Tasks

You are expected to perform the following 4 tasks by using task selection inputs S0 and S1:

1. If $S1 = 0$ and $S0 = 0$ then check whether the second part of the input is divisible by 2 but not 3.
2. If $S1 = 0$ and $S0 = 1$ then check whether the second part of the input is divisible by 3 but not 2.
3. If $S1 = 1$ and $S0 = 0$ then check whether the second part of the input is divisible by both 2 and 3.
4. If $S1 = 1$ and $S0 = 1$ then check whether the second part of the input is neither divisible by 2 nor 3.

The second part of the input mentioned above is denoted by $X3, X2, X1, X0$ from most significant to least significant digit. Below examples are given to clarify the tasks.

Example 1: If $S1 = 0$ and $S0 = 0$ and the input in decimal format is 2, then the output Y is 1 since 2 is divisible by 2 but not 3.
(S1 S0 X3 X2 X1 X0 → Y) (0 0 0 0 1 0 → 1)
The decimal 2 is 0010 in binary form. This is the first task since $S1 = 0$ and $S0 = 0$.

Example 2: If $S1 = 0$ and $S0 = 1$ and the input in decimal format is 9, then the output Y is 1 since 9 is divisible by 3 but not 2.
(S1 S0 X3 X2 X1 X0 → Y) (0 1 1 0 0 1 → 1)
The decimal 9 is 1001 in binary form. This is the second task since $S1 = 0$ and $S0 = 1$.

Example 3: If $S1 = 1$ and $S0 = 0$ and the input in decimal format is 0, then the output Y is 1 since 0 is both divisible by 2 and 3.
(S1 S0 X3 X2 X1 X0 → Y) (1 0 0 0 0 0 → 1)
The decimal 0 is 0000 in binary form. This is the third task since $S1 = 1$ and $S0 = 0$.

Example 4: If $S1 = 1$ and $S0 = 1$ and the input in decimal format is 7, then the output Y is 1 since 7 is neither divisible by 2 nor 3.
(S1 S0 X3 X2 X1 X0 → Y) (1 1 0 1 1 1 → 1)
The decimal 7 is 0111 in binary form. This is the fourth task since $S1 = 1$ and $S1 = 0$.

Example 5: If $S1 = 0$ and $S0 = 1$ and the input in decimal format is 6, then the output Y is 0 since 6 is both divisible by 2 and 3 and hence does not satisfy the condition given in task 2.
(S1 S0 X3 X2 X1 X0 → Y) (0 1 0 1 1 0 → 0)
The decimal 6 is 0110 in binary form. This is the second task since $S1 = 0$ and $S0 = 1$.

Example 6: If $S1 = 1$ and $S0 = 0$ and the input in decimal format is 10, then the output Y is 0 since 10 is divisible by 2 but not 3 and hence does not satisfy the condition given in task 3.

(S1 S0 X3 X2 X1 X0 → Y) (1 0 1 0 1 0 → 0)
The decimal 10 is 1010 in binary form. This is the third task since $S1 = 1$ and $S0 = 0$.

Example 7: If $S1 = 0$ and $S0 = 0$ and the input in decimal format is 12, then the output Y is 0 since 12 is both divisible by 2 and 3 and hence does not satisfy the condition given in task 1.
(S1 S0 X3 X2 X1 X0 → Y) (0 0 1 1 0 0 → 0)
The decimal 12 is 1100 in binary form. This is the first task since $S1 = 0$ and $S0 = 0$.

Example 8: If $S1 = 1$ and $S0 = 1$ and the input in decimal format is 15, then the output Y is 0 since 15 is divisible by 3 but not 2 and hence does not satisfy the condition given in task 4.
(S1 S0 X3 X2 X1 X0 → Y) (1 1 1 1 1 1 → 0)
The decimal 15 is 1111 in binary form. This is the fourth task since $S1 = 1$ and $S0 = 1$.

4 Free Session

There will be a free session week after your homework is announced. You will have 2 hours in your free session slot. During the free session, you will try to build your circuit on a breadboard by using IC components, and you will practice how to handle possible problems related to physical circuit.

5 Demo Session

There will be a 2-hour-long demo session week following the free session week. In demo session:

- You will take a short quiz about the logic concepts that involve the coverage of this lab.
- You will reconstruct your circuit on your breadboard.
- You will show that the circuit drawn in Logisim works as specified.

6 Labelling Specifications

- You have to use "pins" for your inputs and outputs. Only set "label" property of the "pin" objects, do not add a "label" object.
- Your input pins should be labelled as X0, X1, X2, X3, S0 and S1.
- Label properties are case-sensitive. Note that all labels consist of an uppercase letter followed by a number. Please be very careful on correct naming of labels.
- Your output pin should be labelled as Y.
- If you need to feed any input with a constant value, you can use a constant gate. This gate is under CENG232 gates. We will only set values for X0, X1, X2, X3, S0 and S1.

7 Deliverables

1) Submit the circuit named "lab2.circ" prepared in Logisim, which is your preliminary work, via COW until the specified deadline. The evaluation of the submission will be a black-box testing.

2) In demo session, you will reconstruct and show that the circuit drawn in Logisim works. This part will be graded in lab (Demo Session).

Submission of a working circuit is a must to attend DEMO lab sessions. You should use CENG version of Logisim which is available on COW. Circuits designed with other tools or not named properly will not be graded!

8 What To Bring In The Lab

- Print-out of submitted file of the circuit.
- Chips and their data-sheets. (www.alldatasheet.com)
- Pencil, as you will have a quiz at the very beginning of the DEMO lab.