

# ES 4 Individual Assessment 1

Tufts University

Due Tuesday, 2 March, 11:59pm on Gradescope

## Instructions:

1. This assignment is intended to help you and I evaluate your progress by pushing you to apply what you know in new ways. Think of it as a checkpoint, rather than a final tally of your understanding.
2. You may consult your notes, the textbook, other books, or the internet while working on this assignment. However, you may not discuss it with anyone else (whether in the course or not) until after the deadline.
3. Please print this out or mark up the PDF directly, rather than using your own notebook. It makes it much easier to grade if everyone's answers are in the same place on the page. Submit your completed assessment on Gradescope, just like the homework.
4. If you have a question about the assessment, please post an *instructors-only* question on Campuswire.
5. Before starting, please put an 'X' somewhere on each line to indicate how confident you feel with each of the concepts so far:

### Logic gates

Clueless  Very confident

### Boolean algebra

Clueless  Very confident

### Logic diagrams

Clueless  Very confident

### Multiplexers

Clueless  Very confident

6. Please sign the statement below and include this page with your submission.

I certify that I have neither given nor received unpermitted aid on this assignment.

Signature: \_\_\_\_\_ Date: \_\_\_\_\_

Name: \_\_\_\_\_

## Introduction

It is a dream come true. The COVID pandemic is finally over, and you're taking a much-needed vacation. From the window of the airplane, you watch clouds tracing their paths across the ocean far below. Your mind wanders, daydreaming of palm trees and warm breezes and Karnaugh maps.

BANG! The dream turns to a nightmare as an engine catches fire and the plane begins to nosedive. The pilot deftly regains control of the plane and is able to make a crash landing on the beach of a small uninhabited island. It will be at least a week before any hope of rescue.

While others head off to find food and shelter, you begin scavaging the wreck for anything that might be useful. Peering toward the back of the cargo hold, you you spy a box labeled "Digital Electronics". Time to show off your engineering skills! But to your dismay, the box does not contain any modern circuit components, let alone any UPduinos. After you pull out some breadboards and wire, the only thing left in the box is a package of chips labeled 74LS51 and a tattered datasheet (conveniently, the datasheet is also available [on the course website](#)). Reading it, you discover that the parts implement an odd combinational circuit known as an "AND-OR-Invert gate" (commonly abbreviated AOI).

### Question 1: Analyzing your components

- (a) [3 pts] Write the truth table for the 2-wide, 2-input AOI gate, following the logic equation and/or logic diagram in the datasheet.

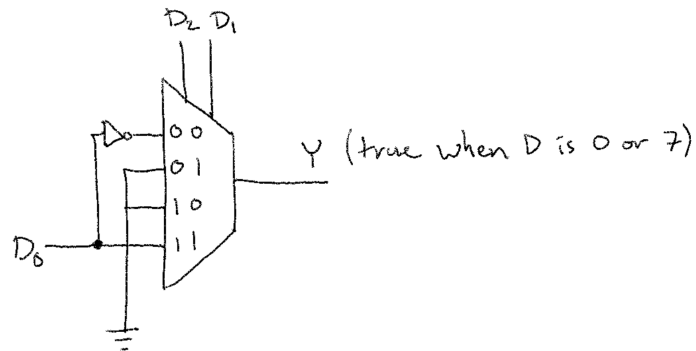
- (b) [1 pt] How many rows would the truth table for the 2-wide, 3-input AOI gate have?

(c) [3 pts] How many rows of the 2-wide, 3-input AOI truth table have a 1 as the output? Explain how you got your answer.

(d) [5 pts] Draw a logic diagram showing how you could wire up the 2-wide, 2-input AOI gate to act as an inverter. (This is a colossal waste, but when you're stranded on a desert island with nothing but 74LS51s, you do what you gotta do.)

## Question 2: Building a Sunday indicator

Like Robinson Crusoe, you decide that it is of utmost importance to keep track of which day is Sunday. The day of the crash is a Sunday, which you define to be Day 0. You happen to have a “multiple-of-seven” circuit scrawled in your notebook, which could be used to tell if the current day is Sunday<sup>1</sup>:



- (a) [4 pts] Write a boolean equation for the logic function that this computes. You can use  $D_2$ ,  $D_1$ , and  $D_0$  to represent the bits of the day.
- (b) [6 pts] Show how you would wire up the AOI gate(s) to perform this logic function. You can use any number and combination of 2-input and 3-input AOI gates of the configuration shown in the datasheet. You can also use the symbol for an inverter, since you figured out how to make that in part 1(d).

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<sup>1</sup>What luck! If only you'd thought to bring your lab kit, too.

### Question 3: Extending the Sunday indicator

As the days pass, it gradually becomes clear that you're going to be on the island a lot longer than anticipated, and you'll need to extend your Sunday detector to work beyond 8 days.


[5 pts] As a first step, figure out how you could use AOI gates to perform an AND operation with at least 4 inputs. *Note: I'm more interested in your thought process than your final answer, so explain your approach and the parts you've figured out, even if you don't get to a final answer.*

## Question 4: Reflection

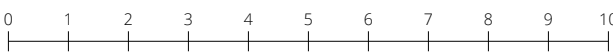
(a) [1 pt] How long did you spend on this assessment?

(b) [1 pt] Now that you've completed the assessment, how well do you feel you understand each of the following topics?

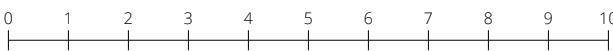
### Logic gates

Clueless  Very confident

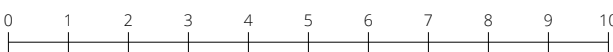
### Boolean algebra

Clueless  Very confident

### Logic diagrams

Clueless  Very confident

### Multiplexers

Clueless  Very confident

If your ratings changed, why?