Worksheet 3 (Tutorial)

This worksheet is divided into two parts. The first part contains exercises on the material covered in lectures 5 and 6. You should attempt the exercises before your tutorial. During the tutorial, your tutor will work through any exercises which have caused problems.

The second part is preparation for next week's lab exercise. You will have time to work on this part during the tutorial.

Before the Tutorial

Logic Circuits

In each of the following cases, draw a circuit which calculates the result r from inputs x, y and z.

1. $r = x$ AND $(y$ OR $z)$
2. $r = (x$ AND $($NOT $y))$ AND $($NOT $z)$
3. $r = (x$ AND $y)$ OR $(x$ AND $z)$

Truth Tables

4. Work out a truth table for each of the functions in the previous section.

Definitions in terms of NOR

Use truth tables to check the following equations.

5. NOT $x = x$ NOR x
6. x OR $y =$ NOT$(x$ NOR $y)$
7. x AND $y = ($NOT $x)$ NOR $($NOT $y)$

Algebraic Notation

8. Rewrite the logical expressions in the **Logic Circuits** section, using algebraic notation.

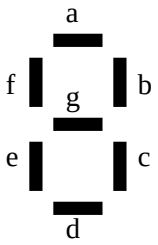
Multi-input Gates

9. How many 2-input AND gates are needed to synthesize a 4-input AND gate? A 6-input AND-gate? An 8-input AND gate? Can you say anything in general about the number of 2-input gates needed to synthesize an n-input gate?

Algebraic Laws

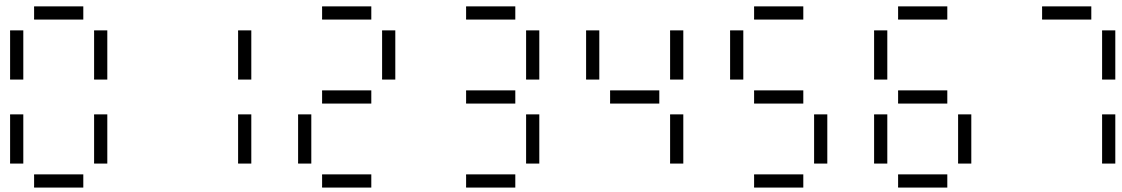
10. Use truth tables to verify some of the algebraic laws (Lecture 6, Slides 7, 8 and 9).

During the Tutorial



Digital watches and other electronic devices often use a "7 segment display": there are 7 segments (bars) which can be either on or off. The display has 7 inputs, $a \ldots g$, which are used to control the segments. If an input is 1, the corresponding segment is on (black). If an input is 0, the corresponding segment is off (white).

Here are the combinations of segments which are usually used to display the digits from 0 to 7.



Designing a 7 segment display driver

The aim of the exercise, and next week's lab, is to design a circuit which converts a 3 bit binary input, representing a number between 0 and 7, into the correct values for the inputs $a \ldots g$ of the display. We'll call the three inputs x, y, z (so, for example, if we want to display the number 6, which is 110 in binary, the inputs will be $x = 1$, $y = 1$, $z = 0$).

1. Work out a truth table showing $a \ldots g$ as functions of x, y, z.
2. After Lecture 7 this week, you will be able to use the truth table to work out formulae for $a \ldots g$. If your tutorial is after the Tuesday lecture then you can do this now.
3. After Lecture 8 this week, you will be able to use Karnaugh maps to simplify these formulae. If your tutorial is after the Thursday lecture then you can do this now.