MASSACHUSETTS INSTITUTE OF TECHNOLOGY
DEPARTMENT OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

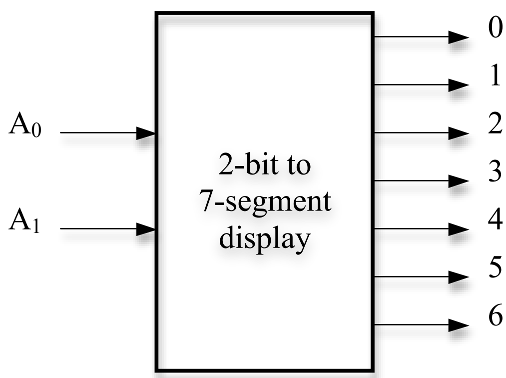
6.111 Introductory Digital Systems Laboratory
Fall 2008

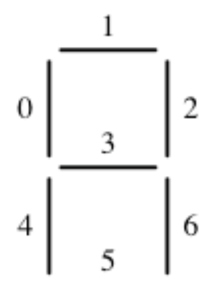
Lecture PSet #1
Due: Tue, 09/09/08

Problem 1. In Middle Earth, Hobbit logic designers use 4-valued Elfen logic where digital inputs and outputs can take on one of four values. How many different Elfen logic functions are there with 2 inputs and 1 output? Hint: How many rows are there in the truth table for a 2-input function in a 4-valued logic? How many ways can you fill in each row in the output column?

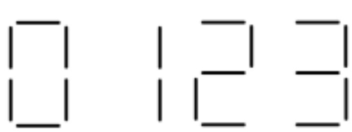
Problem 2. Consider a 4-input Boolean function that has the value 1 whenever exactly two of its inputs are 1. Give a truth table for this function.

Problem 3. A 2-bit binary-to-seven-segment decoder takes a 2-bit binary number A_1A_0 as input and produces seven outputs, one for each "segment" in a standard display.





Given the appropriate binary input, this decoder produces outputs that light up the display in the following manner:



A "1" on an output lights up the corresponding segment. The input values are encoded as A_1A_0 = 00 = "0", 01 = "1", 10 = "2", and 11 = "3".

Give a truth table for the decoder.

(see other side)

Problem 4. Truth tables for functions with large number of inputs will have lots of rows. It's sometimes possible to keep truth tables more compact (and hence easier to read and understand) if we allow the use of "don't cares" when specifying an input value. A "don't care", written as "—" or "X" in the appropriate input column, indicates that the value of the output doesn't depend on that input given the specified values for the other inputs. For example, here are two equivalent truth tables for the 2-input Boolean OR function: if either input (A,B) is "1", the output (Z) is "1"; otherwise the output is 0.

A	B	Z
0	0	0
0	1	1
1	0	1
1	1	1

A	B	Z
0	0	0
1	-	1
-	1	1

Note that one has to be careful when building truth tables with don't cares: the truth table must still specify only one possible output value for any particular combination of inputs.

Consider the truth table for an 7-input priority encoder which examines its seven inputs (I1, I2, I3, I4, I5, I6, I7) and outputs a 3-bit binary number indicating the highest-priority input which has a value of "1", where I1 has the highest priority and I7 the lowest. If no inputs are "1", the encoder outputs "000". If I1 is "1", the encoder outputs "001". If I1 is "0" and I2 is "1", the encoder outputs "010". And so on…

Normally the truth table for a 7-input logic function would have 128 rows. Give a much smaller truth table for the encoder using "don't cares". Hint: you'll only need 8 rows.