**UMBC CMPE 212, Spring 2023**

**Lab 6 do-at-home part, ~~due Two weeks from the date assigned~~**
**That day falls on Wed 22 nd March which is in the spring break**
**Therefore it will be due on Friday the 17-th of March 2023 at 11:59 P.M. EDT**
**(note that EST ends and "Daylight Savings Time" starts on the 12th of March).**

**Objectives**

**To understand ≈ [(see/feel/perceive) = experience + appreciate and then + adore[1]] the following**
**(1) The full power of the Quine-McClusky Tabular minimization method.**
**(2) Difference between local/individual/separate minimization versus**
**global simultaneous minimization (K-maps cannot do this, only Q-M can).**
**(3) Trade-offs when Designing with or without "don't-cares".**

**Designing a 7-segment display provides an excellent opportunity to achieve all of the above objectives.**

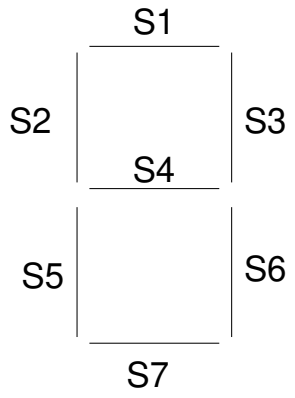


Figure 1: Schematic diagram of a 7-segment display

Suppose that you have 4 input bits that encode a decimal digit. You have to light the segments that display the value of the decimal digit encoded by the current values applied/present at the input bits.

Assume that the switching output "1" applied to an LED turns that LED segment ON, and
applying a signal of logic level "0" keeps the LED segment off.

Next, consider simple examples:

if the input-bits are (0,0,0,0) then the decimal digit is 0.
Therefore all the segments, except the segment labeled "S4" should be turned on.

Likewise, if the input bits are (0,1,0,0) then the decimal digit is 4.
Therefore only segments labeled S2, S3, S4 and S6 should be turned on.

If the input bits are (0,1,1,0) then the decimal digit is 6.
Therefore all the segments, except the segment S3 should be turned on.

**Part 1 : Use don't-cares**

Assume that the inputs are always correct; or in other words;
the decimal value of the 4 input bits never exceeds "9".
Therefore, you should use "don't cares" for outputs corresponding to inputs with decimal values 10 thru 15.

[1] Just joking as usual

Write out the truth-table for each segment (S1 thru S7) including the don't cares.

Next, ⋆ **simultaneously** ⋆ **minimize all 7 outputs to generate SOP expressions using the Q-M method.**
Show your lists, covering table and the final globally minimum realization. (you have to do this by hand, write out the lists, then show the covering table etc.)

Now implement your optimal expressions using up to 4-input AND/OR gates and inverters; then draw your gate diagram.

**part 2 : No don't-cares**
Now you want to display lowercase "a" thru "f" corresponding to inputs with decimal values 10 thru 15 ; respectively. (to output the 'f", light segments S1, S2, S4 and s5 which makes it an upper case "F" which is acceptable for our purpose.)

Now re-write the truth tables for each segment (understand that the don't cares are now gone).

Then, simultaneously minimize all 7 outputs again.
As in part 1; show your lists, covering table, optimal SOP expressions for each segment.
Then implement your expressions using upto 4 input AND/OR gates and inverters; and draw/show your gate diagram.

**Questions:**

(1) Do you see the difference between local versus global minimization ?
(you can ask chatGPT or any other entity of your choice, but do not write essays or poems, the correct answer is very short; no more than a few lines at most.)

(2) Did you observe any trade-offs associated with the use of don't cares ? (be brief).