ECE 465, Spring 2005, Instructor: Prof. Shantanu Dutt

Project 1 : Due Tue, March 1

Goal

The goals of this project are: 1) Solving a real-life design problem in which, besides correctness, the main objective is minimizing the hardware cost of the design by sharing gates/product-terms across a number of outputs/functions of the digital circuit. 2) Using the schematic capture tool of the Quartus software to specify and simulate your design for correctness.

Design Problem

You need to design two minimum-cost circuits, one a gate-based circuit and another a PLA-based circuit, for implementing a BCD-to-7-segment decoder whose block-level schematic and truth table (TT) are given below. Note that input values 10-15 will never occur at the input of your circuit and thus the corresponding values in the output columns of the TT should be don't cares as shown.

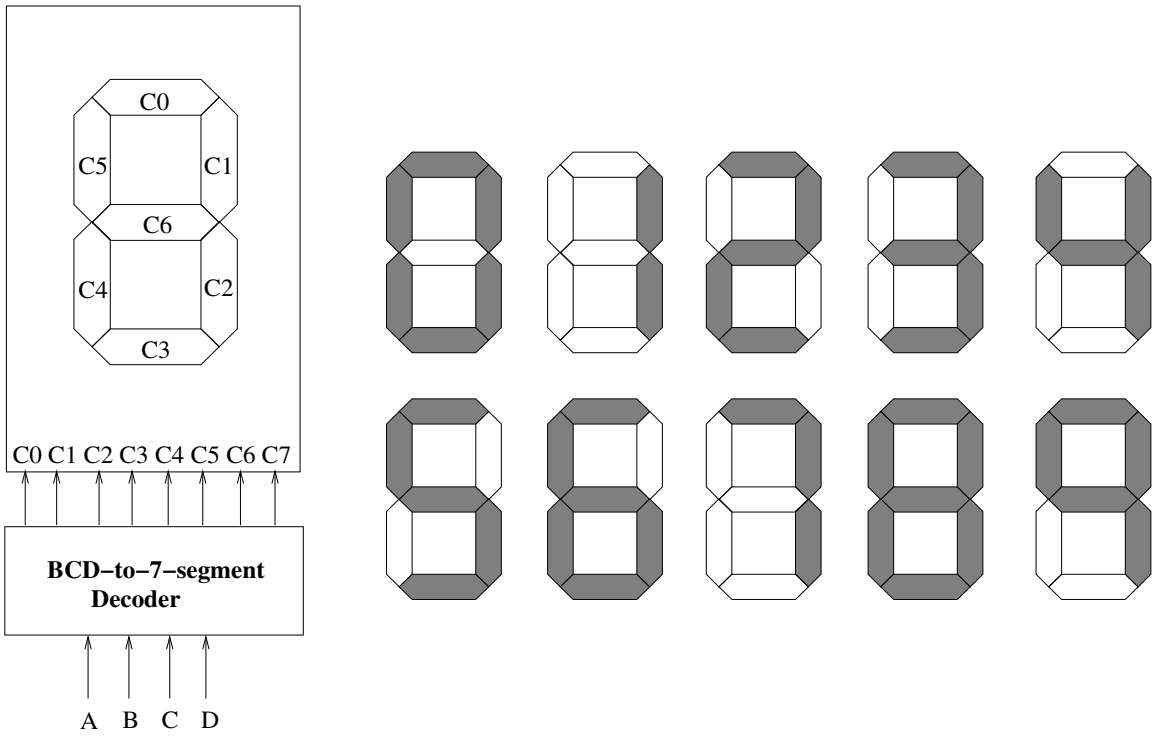

Figure 1: Digital display system for BCD (binary-coded decimal) numbers.

A	B	C	D	C_0	C_1	C_2	C_3	C_4	C_5	C_6
0	0	0	0	1	1	1	1	1	1	0
0	0	0	1	0	1	1	0	0	0	0
0	0	1	0	1	1	0	1	1	0	1
0	0	1	1	1	1	1	1	0	0	1
0	1	0	0	0	1	1	0	0	1	1
0	1	0	1	1	0	1	1	0	1	1
0	1	1	0	1	0	1	1	1	1	1
0	1	1	1	1	1	1	0	0	0	0
1	0	0	0	1	1	1	1	1	1	1
1	0	0	1	1	1	1	0	0	1	1
1	0	1	0	X	X	X	X	X	X	X
1	0	1	1	X	X	X	X	X	X	X
1	1	0	0	X	X	X	X	X	X	X
1	1	0	1	X	X	X	X	X	X	X
1	1	1	0	X	X	X	X	X	X	X
1	1	1	1	X	X	X	X	X	X	X

Table 1: Truth table for the BCD to 7-segment decoder.

You need to use the multi-function QM method to minimize the cost of the two implementations of the circuit by maximizing sharing of hardware components (gates in the gate-based circuit, and product-terms/AND-lines in the PLA-based circuit).

Gate-based circuit: In order to minimize the cost of the gate-based circuit, use the cost of a PI with more than one literal as (# of literals + 1) and the cost of a PI with one literal as 1.

(a) Obtain the final SOP expression for each function using multi-function QM with the above PI cost. Clearly derive and state the cost of the circuit and the total # of unique product terms across the final expressions of all the seven functions. **500**

(b) Draw the final gate-based circuit clearly showing the sharing of gates among the different outputs. **50**

PLA-based circuit: In order to minimize the cost of the PLA-based circuit, use the cost of a PI as 1 (irrespective of the # of literals in its product term).

(a) Obtain the final SOP expression for each function using multi-function QM with the above PI cost. Clearly derive and state the total # of unique product terms across the final expressions of all the seven functions. This is the cost of a PLA-based circuit. **200**

(b) Draw the final PLA-based circuit using the symbolic notation done in class. **50**

Implementation and Simulation using Quartus

You are required to implement and simulate your gate-based design obtained above using the Quartus CAD software as specified below. **400**

1. The project is to be done in groups of 3-4 for undergrads and 2 for grads as determined by you beforehand and reported to the TA.

2. Choose the schematic capture tool in Quartus to specify your design.

3. Perform simulations based upon the input file provided by the TA.

4. Device family to be used for the project is Cyclone which is selected by default in Quartus.

5. You need to submit a clearly written project report detailing all your work including all the steps and results of the design process for the two circuits using multi-function QM, use of the schematic capture tool, simulation results and other findings, if any, and conclusions. You need to also clearly state in the project report the final task-distribution among the group members.

6. Students are encouraged to interact with each other, share ideas and ask for help from the instructor or the TA. Copying of the project between groups will, however, not be tolerated and if evidence of copying is detected the concerned groups will be reported for disciplinary action and will fail the course.