CSEE 3827: Problem Set 3 Due: 2/25/09

Complete the following problems. Be sure to show your work for partial credit.

1. An m-bit *thermometer code* for the number k consists of k 1's in the least significant bit positions and $m - k$ 0's in all the more significant bit positions. A *binary-to-thermometer converter* has n inputs and $2^n - 1$ outputs. It produces a $2^n - 1$ bit thermometer code for the number specified by the input. For example, if the input is 110, the output should be 0111111. Design a 3:7 binary-to-thermometer code converter. Specify your design in the way that seems most natural to you, using a block diagram, schematic, or boolean expression (or some combination of these).

2. Design a modified priority encoder that receives an 8-bit input, $A_{7:0}$, and produces two 3-bit outputs, $Y_{2:0}$ and $Z_{2:0}$ and two 1-bit outputs, v and w. v should be TRUE if there are one or more TRUE bits on the input. Y indicates the most significant bit of the input that is TRUE. w should be TRUE if there are two or more TRUE bits on the input. Z indicates the second most significant bit of the input that is TRUE. Specify your design in the way that seems most natural to you, using a block diagram, schematic, or boolean expression (or some combination of these).

3. Design a full adder module with data inputs A and B, carry input C_{in}, sum output S, and carry output C_{out}.

   (a) Using two half adder modules.

   (b) Using a 3:8 decoder and NAND gates.

   (c) Using a four input, 2-bit multiplexer.

4. Design a 4-bit comparator. This comparator takes two 4-bit operands, $A_{3:0}$ and $B_{3:0}$ and has three outputs L, E, and G. The outputs are true when $A < B$, $A = B$, and $A > B$ respectively. Define a single-bit comparator module and show

   (a) how they are wired together to form a 4-bit comparator, and

   (b) boolean expressions describing the behavior of this module