

## CS220: Lab#7

**1.[4 marks]** Implement the finite state machine the next state function of which is shown in Table 1. The machine takes a two-bit input ( $Y[1:0]$ ). The output function is not specified and can be ignored for this question. Suppose a

**Table 1.** Next state function

Current state	Input ( $Y[1:0]$ )	Next state
$S_0$	2'bxx	$S_1$
$S_1$	2'bxx	$S_2$
$S_2$	2'bxx	$S_3$
$S_3$	2'b00	$S_4$
$S_3$	2'b01	$S_5$
$S_3$	2'b1x	$S_6$
$S_4$	2'bxx	$S_7$
$S_5$	2'bxx	$S_7$
$S_6$	2'bxx	$S_7$
$S_7$	2'bxx	$S_8$
$S_8$	2'bxx	$S_9$
$S_9$	2'bxx	$S_{10}$
$S_{10}$	2'b00	$S_{11}$
$S_{10}$	2'b01, 2'b1x	$S_{12}$
$S_{11}$	2'bxx	$S_0$
$S_{12}$	2'bxx	$S_0$

state incrementer can be used to compute the next state along with two dispatch ROMs, a microcode ROM, and a state selection multiplexer. The microcode ROM takes only the current state as input to look up a row and outputs the branch control for computing the next state (note that  $Y$  cannot be used as an input to the microcode ROM). The two dispatch ROMs are used to encode the two branches in the state diagram. The first branch occurs when the current state is  $S_3$  and the second branch occurs when the current state is  $S_{10}$ . The first dispatch ROM stores the next states when the current state is  $S_3$ . The second dispatch ROM stores the next states when the current state is  $S_{10}$ . The input  $Y$  is used to look up a row in the dispatch ROMs.

The ROMs should be implemented as arrays and initialized within an initial block. The current state should be displayed using four LEDs. The state change must take place every time a new input is entered (use any means that you know of to accept the two-bit input  $Y$ ). Additionally, after a state change, if a new input is not entered for two seconds, the state will change based on the last input. You can use the standard 50 MHz clock of the FPGA to count two seconds.

**2.[5 marks]** Construct a hardware that takes as input four three-bit values treated as unsigned numbers and computes the index of the smallest value. For example, if the inputs are 110, 010, 001, and 111, the output is 2 indicating that the input at position two is the smallest (input index starts at zero and ends at three). Use any means that you know of to accept the inputs. Display the inputs in decimal in the first line of the LCD with a comma and

a space between two consecutive inputs. For the aforementioned four inputs, the first line of the display should be 6, 2, 1, 7. Display the output in decimal in the second line of the LCD.