EE214: Combinational Circuits-1

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1 Part-1

1. Design a combinational circuit block using AND, OR, and NOT gates to check if the 4-bit binary input number is a prime number($a_3a_2a_1a_0$)(i.e. one of 2,3,5,7,11,13). The number is to be inputted through the four on-board slide switches (S4-S1) with MSB bit on S4. Output bit represented by Out
   If the input 4-bit number is:
   (a) a prime number, turn `LED8` ON [Out = 1].
   (b) not a prime number, turn `LED8` OFF [Out = 0].

   Show your pen-paper design to your TA. (5)
2. Describe the logic circuit in VHDL and construct a trace-file (code not expected) which tries all 16 input combinations. (5)
3. Simulate (RTL and Gate-Level) the circuit with the generic test-bench and confirm that your circuit functions correctly.(5)
   The format for tracefile should be:
   $a_3a_2a_1a_0 < space > Out < space > mask - bits$
4. Map your logic circuit to the Krypton board.
5. Confirm that the post-synthesis gate level netlist functions correctly.
6. Program the Krypton board and demonstrate to the TA that your implementation works correctly. (3)

2 Part-2

1. Now design a logic circuit using AND, OR, NOT and XOR gates, *4-bit* adder which will:
   (a) Accept two 4-digit numbers $a_3a_2a_1a_0$(A) and $b_3b_2b_1b_0$(B) using eight on-board switches (S8-S5)and (S4-S1)respectively.
   (b) Check if the two numbers are prime numbers. You are advised to use the block designed in Part-1 for prime number detection and for subtraction use same 4-bit adder that you for addition.
   (c) Design a logic circuit with the specifications shown in the table. Final output should be displayed on the LEDs (LED8, LED7) (l_8l_7)and (LED5-LED1) ($l_5l_4l_3l_2l_1$) as mentioned in table below. Use LED5 to indicate the carry bit. The negative result after subtraction is in 2's complement form the carry bit indicates the sign of result , leave it as it is. Show your design to your TA. (5)

$a_3a_2a_1a_0$	$b_3b_2b_1b_0$	LED8	LED7	LED5-LED1	Comment
prime	prime	ON	ON	A - B	Subtraction
prime	not prime	ON	OFF	A + B	Addition
not prime	prime	OFF	ON	A + B	Addition
not prime	not prime	OFF	OFF	ALL OFF	No Operation

2. Describe the logic circuit in VHDL. (5)
3. Construct a trace-file which simulates for all 256 input combinations. Note: tracefile provided by TA will have negative results after subtraction represented in 2's complement format and carry bit represents sign of the result (5)
4. Simulate the circuit with the generic test-bench and confirm that your circuit functions correctly.
5. Map your logic circuit to the Krypton board.
6. Confirm that the post-synthesis gate level netlist functions correctly. (5)
7. Program the Krypton board and demonstrate to the TA that your implementation works correctly. (5)

3 Part-3: Additional learning

Note: You may try this part after completing Part-1 and Part-2. You need not necessarily complete this part during the lab session.

Multiplexers can be used to implement Boolean functions. In this part you are asked to carry out Part-1 by using only 4-1 mux(s) in the home work assignment as a component, to check if the input four bit number is a valid prime number.
Demonstrate all the steps (simulation and board implementation) to your TA.