ECE 2544: Fundamentals of Digital Systems

Learning Experience F.2: Simple Computer Control Unit Implementation

# Validation Sheet (Page 1)

Name:

Last four digits of your student ID:

Operation implemented: AND NAND (choose one)

Student: The 2nd half of the **Validation Table** lists the elective operations. Delete the rows that contain operations that you did NOT implement. Do NOT change the order of the rows.

You are responsible for correctly modifying data.txt and instruction.txt as described in the specification. Failure to do so will result in incorrect validation results.

GTA: SW[3:0] values from 0000 to 0111 select registers R0-R7. The PC register is displayed for SW[3:0] = 1000. The instruction (IR[15:0]) is displayed for SW[3:0] = 1001. The PC value can also be displayed on the LEDs in binary, but only 8 bits at a time, using SW[4] to toggle between the upper and lower byte.

The student is responsible for correctly modifying data.txt and instruction.txt as described in the specification. Failure to do so will result in incorrect validation results.

1. Program the FPGA on the DE10-Lite board using the Start button on the programmer window.
2. When the programming has successfully completed, reset the design by pressing and holding KEY1, and while keeping KEY1 pressed, pressing and releasing the KEY0 pushbutton.
3. Set the switches to “1000” to show the program counter (PC). Press and release KEY0. The PC should read 0x01.
4. Set the switches to “0010”, and record the 16-bit value for R2 in the Validation Table (next page) as four-digit hex.
5. **Compare the four digits from step 4 to the last four digits of the student’s ID number. If the four digits do not match the last four digits of the student’s ID number, STOP THE VALIDATION. DO NOT CONTINUE. ENTER A VALIDATION SCORE OF 0**
6. Use KEY0 to step through the remaining instructions in the program, recording the 16-bit value for the appropriate register after each KEY0 press.

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# Validation Sheet (Page 2)

**Validation Table**

| ***PC value (in hex)***  ***shown on LEDs[7:0] for SW[4]=0*** | ***Instruction Description*** | ***Register*** | ***SW[3:0] setting*** | ***Expected Results*** | ***X*** |
| --- | --- | --- | --- | --- | --- |
| **Register Contents**  **(in hex)** |  |
| 0001 | LD R2, R1 | R2 | 0010 | Last 4 digits of student’s ID |  |
| IF R2 DOES NOT CONTAIN THE STUDENT’S ID, STOP THE VALIDATION | | | | | | |
| 0002 | ADI R1, R1, 1 | R1 | 0001 | 0001 |  |
| 0003 | LD R2, R1 | R2 | 0010 | 72B5 |  |
| 0004 | ADI R1, R1, 1 | R1 | 0001 | 0002 |  |
| 0005 | LD R3, R1 | R3 | 0011 | 5D84 |  |
| 0006 | ADI R1, R1, 1 | R1 | 0001 | 0003 |  |
| 0007 | LD R4, R1 | R4 | 0100 | F0F3 |  |
| 0008 | ADI R1, R1, 1 | R1 | 0001 | 0004 |  |
| 0009 | LD R5, R1 | R5 | 0101 | EA74 |  |
| 000A | ADD R7, R2, R3 | R7 | 0111 | D039 |  |
| 000B | SUBI R7, R4, 6 | R7 | 0111 | F0ED |  |
| 000C | NOT R7, R2 | R7 | 0111 | 8D4A |  |
| 000D | MOD8 R7,R5 | R7 | 0111 | 0004 |  |
| 000E | MOVA R7, R0 | R7 | 0111 | 0000 |  |
| 000F | DIV4 R7,R5 | R7 | 0111 | FA9D |  |
| 0010 | SUB R7, R4, R5 | R7 | 0111 | 067F |  |
| 0011 | AND R7, R2, R4 /  NAND R7, R2, R4 | R7 | 0111 | 70B1 /  8F4E |  |
| 0012 | ANDI R7, R2, 6 /  NANDI R7, R2, 6 | R7 | 0111 | 0004 /  FFFB |  |
| Student: For the remaining rows,  1) Delete rows containing instructions you did NOT implement.  2) Do NOT change the order of instructions. | | | | | | |
|  | SUBBA R7, R2, R5 | R7 | 0111 | 77BF |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  | NEGA R7, R2 | R7 | 0111 | 8D4B |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  | NEGB R7, R5 | R7 | 0111 | 158C |  |
|  |  |  |  |  |  |
|  | NOR R7, R4, R5 | R7 | 0111 | 0508 |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  | NOTB R7, R5 | R7 | 0111 | 158B |  |
|  |  |  |  |  |  |
|  | CSL R7, R5 | R7 | 0111 | D4E9 |  |
|  |  |  |  |  |  |
|  | CSR R7, R2 | R7 | 0111 | B95A |  |
|  |  |  |  |  |  |

**Comments**: (only required if something is unusual or wrong)