

ECE 425, Sp 2023  
Introduction to VLSI System Design  
MP2

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**2. List the eight ALU functions and explain how you implemented each of them.**

I created a table that shows all possible  $I_{3-5}$  control signals and the function each combination goes with. Then I created new columns for when I need to invert either input to calculate the function, 0 if I don't need to invert, 1 if I do. Then I labeled each function with the logic block used to calculate the result of the function, ADD if I use the ADD logic block, OR for OR gate, etc. Then I created the sel\_f signal based on what the inputs to the 4x1 MUX were that selected the function output.

**Table 1**

$I_5$	$I_4$	$I_3$	function	inv_r	inv_s	operation	sel_f[1:0]
0	0	0	$R + S$	0	0	ADD	00
0	0	1	$S - R$	1	0	ADD	00
0	1	0	$R - S$	0	1	ADD	00
0	1	1	$R \vee S$	0	0	OR	01
1	0	0	$R \wedge S$	0	0	AND	10
1	0	1	$\overline{R} \wedge S$	1	0	AND	10
1	1	0	$R \oplus S$	0	0	XOR	11
1	1	1	$R \overline{\oplus} S = R \oplus \overline{S}$	0	1	XOR	11

Using the values found in *Table 1*. I created functions for inv\_r, inv\_s, sel\_f[0], and sel\_f[1] in terms of  $I_5$ ,  $I_4$  and  $I_3$ , which are:

$$\text{sel\_r} = \sim I_4 \& I_3$$

$$\text{inv\_s} = \sim I_5 \& I_4 \& \sim I_3 \mid I_5 \& I_4 \& I_3$$

$$\text{sel\_f}[0] = I_4 \& I_3 \mid I_5 \& I_4$$

$$\text{sel\_f}[1] = I_5$$

These functions, along with their complements, were implemented in control.v and send to the datapath via pins.