

CS362 Computer Design Spring 2018

H.W. 5: ALU, Chip economy, RAM/ROM (100 points)

This assignment is due via GradeScope. You must complete your work in the space provided below and upload your answers as a PDF to GradeScope.

1. Assume that you have an ALU where the functionality is controlled by a 2 to 4 multiplexer with inputs $s_0 s_1$. Assume that the inputs 10 cause the ALU to add two inputs, and the inputs 01 cause it to subtract. ALU control is determined by the icode and ifun of an instruction. The instructions rmmovq, mrmovq and add all result in the ALU performing an add. The instruction sub results in the ALU performing a subtraction. Fill the truth table, write the equations and draw the combinatorial logic circuit that will translate from the icode & ifun to the multiplexor inputs. Assume all the other values in the truth table are don't cares. (Use Table 1 for icode & ifun values of the instructions) (30 pts)

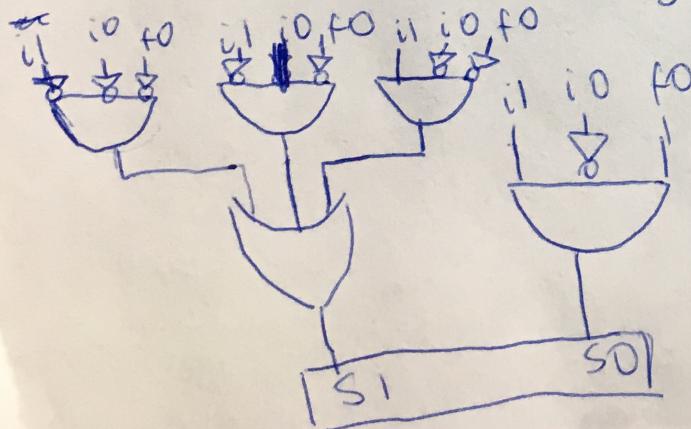
Instruction	icode	ifun
rmmovq	4	0
mrmovq	5	0
add	6	0
sub	6	1

Table 1: icode and ifun for instructions.

Truth Table

Operation	icode				ifun				Mux	
	i3	i2	i1	i0	f3	f2	f1	f0	s1	s0
rmmovq	0	1	0	0	0	0	0	0	1	0
mrmovq	0	1	0	1	0	0	0	0	1	0
add	0	1	1	0	0	0	0	0	1	0
sub	0	1	1	0	0	0	0	1	0	1

$$\begin{aligned}
 S_1 &= (\bar{i}_3 * i_2 * \bar{i}_1 * i_0) * (\bar{f}_3 * \bar{f}_2 * \bar{f}_1 * \bar{f}_0) \\
 &+ (\bar{i}_3 * i_2 * \bar{i}_1 * \bar{i}_0) * (\bar{f}_3 * \bar{f}_2 * \bar{f}_1 * f_0) \\
 &+ (\bar{i}_3 * i_2 * i_1 * \bar{i}_0) * (\bar{f}_3 * \bar{f}_2 * f_1 * \bar{f}_0) \\
 &+ (\bar{i}_3 * i_2 * i_1 * i_0) * (\bar{f}_3 * \bar{f}_2 * \bar{f}_1 * f_0) \\
 S_0 &= (\bar{i}_3 * i_2 * i_1 * i_0) * (\bar{f}_3 * \bar{f}_2 * \bar{f}_1 * f_0) \\
 &+ (\bar{i}_1 * \bar{i}_0 * \bar{f}_0) + (\bar{i}_1 * i_0 * f_0) + \\
 &\quad (i_1 * \bar{i}_0 * \bar{f}_0) \\
 S_0 &= i_1 * \bar{i}_0 * f_0
 \end{aligned}$$



2. You have a 4 by 4096 SRAM memory. What size is it in kilobytes? (10 pts)

$$4 \times 4096 = 16384 \text{ bits}$$

3. You have a 4 by 4096 SRAM memory. How many transistors does it contain? Ignore the multiplexor and only count the transistors used to store values (i.e. in the cells). (10 pts)

$$6 * 16384$$

4. You have a 4 by 4096 DRAM memory. How many transistors and capacitors does it contain? Ignore the multiplexor and only count the transistors/capacitors used to store values. (10 pts)

Transistors:

Capacitors:

5. Your SRAM cost you \$20 and takes 1ns to access. How much did your DRAM cost and how much time does it take to access? (10 pts)

Cost:

\$

Time to Access:

ms

6. A 4-bit EEPROM has the floating-hat transistors that correspond to its three most significant bits programmed, and the rest unprogrammed. What value is it holding (in binary)? (10 pts)

7. A wafer holds 20 3GB chips which can be sold for \$30 each, or 100 1 GB chips which can be sold for \$5 each. Assume flaws in the wafer will make 5 chips un-useable. How much money will you make with each size chip? (10 pts)

For 3 GB Chips:

For 1 GB Chips:

8. You have four 8 x 1024 memory chips. You compose them together to make memory with 12 bit words. A) How many bits are the memory addresses for your resulting memory? B) How many bits of these addresses will be used as input for the decoder? (10 pts)

A)

B)