
IC220 Set #14:

Controlling the Single Cycle Implementation (Chapter Five)

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ADMIN

- **Reading**
 - **Sections 5.5, 5.10, 5.11**
 - **Section 5.6 (first two pages)**

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Control

Selecting the
and controlling the
based on the

- Outline:
 1. Overview
 2. Controlling the ALU
 3. Controlling multiplexors and register writes

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Part 1: Control Overview

Example #1: `add $8, $17, $18`

000000	10001	10010	01000	00000	100000
op	rs	rt	rd	shamt	funct

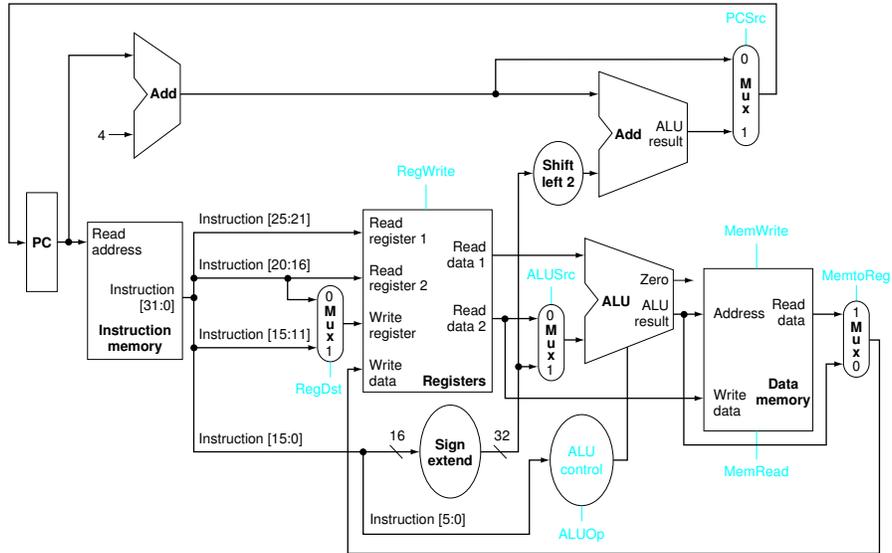
Example #2: `lw $2, 12($1)`

100011	00001	00010	0000000000001100
op	rs	rt	16 bit offset

	add \$8, \$17, \$18	lw \$1, 12(\$2)
A. What should the register file do?		
B. What should the ALU do?		
C. What should the muxes do?		

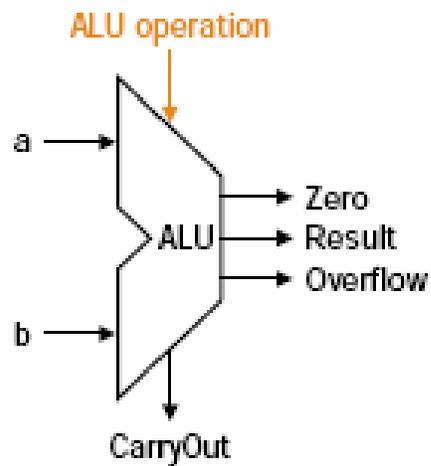
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Part 1 – Control Overview



Recall: ALU Control and Symbol

ALU Control Lines	Function
0000	AND
0001	OR
0010	Add
0110	Subtract
0111	Set on less than
1100	NOR



Part 2: ALU Control Scheme

Instruction OpCode	Instruction op	Funct Field	Desired ALU action	ALU control input
lw (35)	load word	000000		
sw (43)	store word	000000		
beq (4)	branch equal	000000		
R-type (0)	add	100000		
R-type (0)	subtract	100010		
R-type (0)	AND	100100		
R-type (0)	OR	100101		
R-type (0)	Set on less than	101010		

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Part 2: ALU Control

- Must describe hardware to compute 4-bit ALU control input given

1. Instruction type

00 = lw, sw

01 = beq,

10 = arithmetic

2. Function code (for arithmetic)

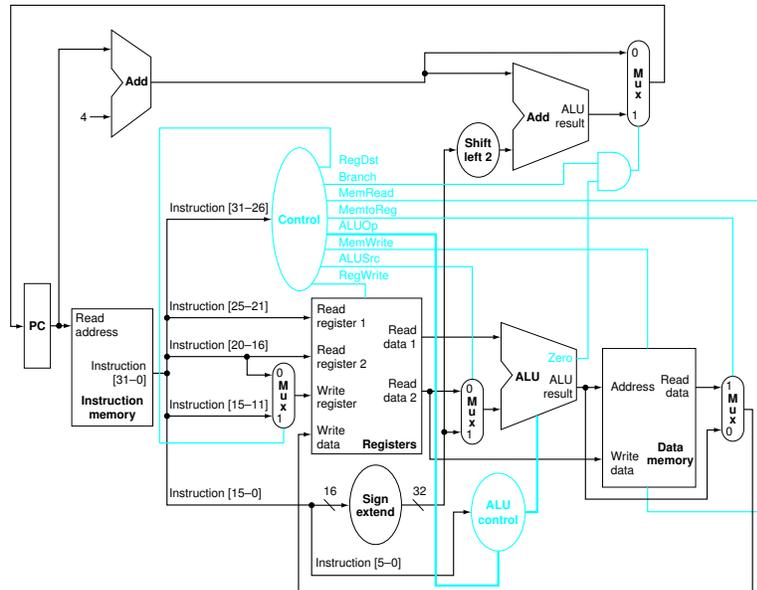
- Describe it using a truth table:

ALUOp		Funct field						Operation
ALUOp1	ALUOp0	F5	F4	F3	F2	F1	F0	
0	0	X	X	X	X	X	X	0010
X	1	X	X	X	X	X	X	0110
1	X	X	X	0	0	0	0	0010
1	X	X	X	0	0	1	0	0110
1	X	X	X	0	1	0	0	0000
1	X	X	X	0	1	0	1	0001
1	X	X	X	1	0	1	0	0111

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Example – Main Control for an ‘add’

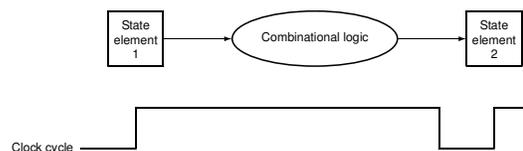
EX: 5-1 ...



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Our Simple Control Structure

- All of the logic is combinational
- We wait for everything to settle down, and the right thing to be done
 - ALU might not produce “right answer” right away
 - we use write signals along with clock to determine when to write
- Cycle time determined by length of the longest path



We are ignoring some details like setup and hold times

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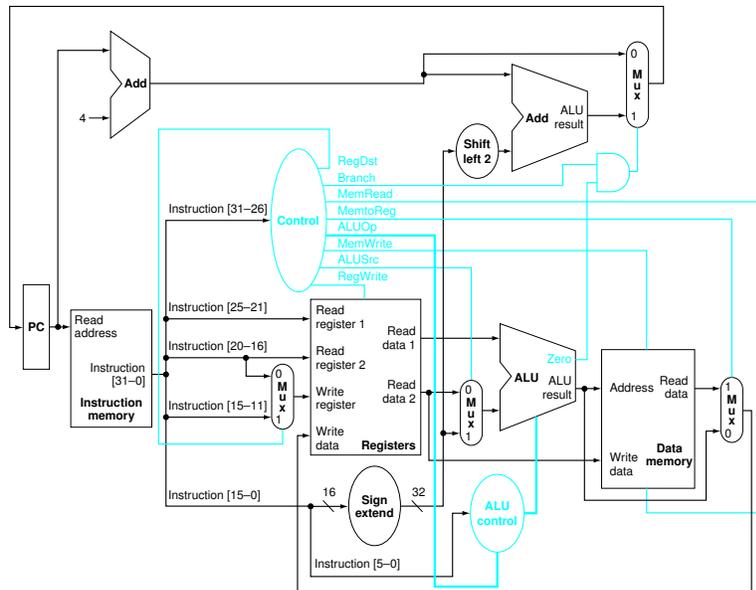
Evaluation – Single Cycle Approach

- Good:

- Bad:

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Adding Jump?



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