

ECE/CS 252 Intro to Computer Engineering

Week 07 Discussion

1

IR = 0001 0000 1000 0100

- Instruction:
- Initial Processor State:
 - PC = 0x3013
 - NZP = 010
 - Register File:
 - R0 = 0x0001
 - R1 = 0x0010
 - R2 = 0x0005
 - R3 = 0x0001
 - R4 = 0xFFFFE
 - R5 = 0x0002
 - R6 = 0xFFFF
 - R7 = 0x0008

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
0	0	0	1	00	001	0	0	0	100							ADD R0, R0, R0 ; Addition (R0 ← R0 + R0, writeback)
0	0	0	1	00	001	1	0000									ADD R0, R0, R0 ; Addition with immediate (R0 ← R0 + 0000(=0), writeback)
0	1	0	1	00	001	0	0	0	000							ADD R0, R0, R0 ; Rotate R0 (R0 ← R0 AND R0, writeback)
0	1	0	1	00	001	1	0000									ADD R0, R0, R0 ; Rotate R0 with immediate (R0 ← R0 AND 0000(=0), writeback)
1	0	0	1	00	00	1	1	1	1	1	1	1	1	1	1	ADD R0, R0 ; Rotate complement (R0 ← NOT(R0), writeback)

2

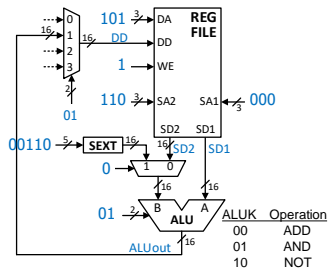
IR = 0101 0010 0011 1111

- Instruction:
- Initial Processor State:
 - PC = 0x3013
 - NZP = 010
 - Register File:
 - R0 = 0x0003
 - R1 = 0x0010
 - R2 = 0x0005
 - R3 = 0x0001
 - R4 = 0xFFFFE
 - R5 = 0x0002
 - R6 = 0xFFFF
 - R7 = 0x0008

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
0	0	0	1	00	001	0	0	0	100							ADD R0, R0, R0 ; Addition (R0 ← R0 + R0, writeback)
0	0	0	1	00	001	1	0000									ADD R0, R0, R0 ; Addition with immediate (R0 ← R0 + 0000(=0), writeback)
0	1	0	1	00	001	0	0	0	000							ADD R0, R0, R0 ; Rotate R0 (R0 ← R0 AND R0, writeback)
0	1	0	1	00	001	1	0000									ADD R0, R0, R0 ; Rotate R0 with immediate (R0 ← R0 AND 0000(=0), writeback)
1	0	0	1	00	00	1	1	1	1	1	1	1	1	1	1	ADD R0, R0 ; Rotate complement (R0 ← NOT(R0), writeback)

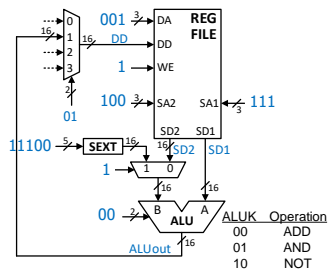
3

What Is The Instruction?



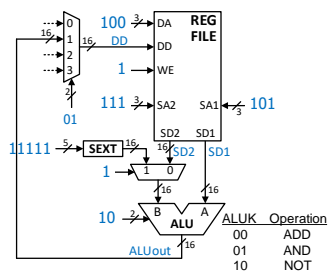
4

What Is The Instruction?



5

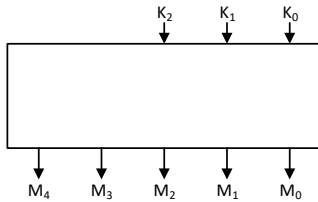
What Is The Instruction?



6

Sign Extension Hardware

- Design the hardware to sign-extend a 3-bit 2's-complement number (K) to 5 bits (M)



8

Programming the LC-3

- Create a program to perform $R4 \leftarrow R3 \times 10_{10}$

Version 1

Version 2

9

Programming for LC-3

- Test it using PennSim for the following values:
 - Initial R3 = 1 Does it work?
 - Initial R3 = 0 Does it work?
 - Initial R3 = -1 Does it work?
 - Initial R3 = x2000 Does it work?
- What if it didn't work?

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Wrapping Up

- Up Next:
 - LC-3 Data Movement Instructions
- Remember your videos and reading
 - Including the video quiz!
- Practice programming!
 - See post-exercise practices on Canvas
 - Remember – programmers don’t just write code – they test and debug too!
- Questions?
