

计算机体系结构 Exercise 04

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7.2. Solution:

The instruction can be interpreted as " $R1 \leftarrow \text{MEM}[\text{x4F08}]$ ".

Meanwhile, x4F08 stores the instruction " $\text{LD } R1 \text{ OFFSET}$ ", where $\text{OFFSET} = \text{x4F08} - \text{PC} = -1$. The corresponding machine language is " $0010 \ 001 \ 1 \ 1111 \ 1111$ ", i.e. $\text{MEM}[\text{x4F08}] = (0010 \ 0011 \ 1111 \ 1111)_B = (\text{x23FF})_H$.

Thus, the content of R1 after executing the instruction is **x23FF**. ■

7.3. Solution:

During the 1st pass, the console treat "AND" as the opcode instead of label. Thus, **it won't be added into the symbol table during the 1st pass.**

During the 2nd pass, the console notices that the format of the instruction is not correct and thus **raises an exception.** ■

7.4. Solution:

The value of LC at the first instruction is x301C .

Since the first instruction with label is the fifth instruction of the program, LC at "TEST" is x301F .

We can calculate the LC at lines with labels likewise. The Symbol Table generated after 1st pass is as follows.

Symbol	Address
TEST	x301F
FINISH	x3027
SAVE3	x3029
SAVE2	x302A

■

7.7. Solution:

```
.ORIG x3000
AND R1, R1, #0    ; reset R1 = 0.
AND R2, R2, #0
AND R2, R2, #1    ; R2 is a mask.
LD R4, NSXT
LOOP AND R3, R0, R2
BRz HOLD          ; If the current bit is 0, do not increment.
```

```

        ADD R1, R1, #1 ; Increment R1 if the current bit is 1.
HOLD    ADD R2, R2, R2 ; Move the mask to the higher bit.
        ADD R4, R4, #1
        BRn LOOP
        HALT

NSXT    .FILL #-16
        .END

```

■

7.10. Solution:

The first instruction, "ADD R3, R3, #30", contains an immediate number whose value is larger than the maximal immediate number accepted in LC-3 ADD instructions (i.e. 15). ■

A feasible solution is replace the instruction with following two instructions:

```

ADD R3, R3, #15
ADD R3, R3, #15

```

■

7.23. Solution:

- (a) ADD R1, R1, #-1
- (b) LDR R4, R1, #0
- (c) ADD R0, R0, #1
- (d) ADD R1, R1, #-1
- (e) BRnzp LOOP

■