LC-3 INSTRUCTION SET - PART I

Operate instructions

* NOT: bitwise complement of Source Register (SR), result stored in Destination Register (DR).

Set condition codes (setcc)
Example:

1001 011 101 11111

Opcode (NOT) Unused

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* ADD (immediate mode): Source Register (SR1) is added to sign-extending bits IR [4:0], result is stored in DR.

Setcc
Example:

0001 001 100 1 1110

Opcode (ADD)

Addressing mode

Question: what happens if IR[5] = 0?

* ADD (register mode): SR1 is added to SR2, result is stored in DR.

Set cc

Example:

0001 001 100 0 00 110

Opcode (ADD)

Addressing
(ADD) Addressing mode

* AND (immediate mode): SRI is bitwise AND to sign-extending bits IR [4:0], result is stored in DR.

Set cc

Example:
0101 001 100 1 1110

Opmode (AND)
* AND (register mode): SR1 is bitwise AND with SR2, result is stored in DR.

Setcc

Example:

01 0 1 000 0 00 1 1 0

Opcodes

(AND)
Data movement instructions

Format:

\[ O_3, O_2, O_1, O_0, R_2, R_1, R_0, A_8, A_7, A_6, A_5, A_4, A_3, A_2, A_1, A_0 \]

Opcode Source / Address generation bits Destination
* LD (load, PC-relative mode):

\[ \text{DR} \leftarrow M[\text{PC} + \text{SEXT(} \text{PC} + \text{offset}\)] \]

\[ \text{Setcc} \]

Example:

0010 010 11010111

Opcode

(LD)
* \text{ST (store, PC-relative mode)}: \\
\[ M[PC + \text{SEXT(PC.offset9)}] \leftarrow SR \]

Example:

0011 010 110101111

Op\_code
(ST)
LDR (load, base register + offset):

\[ \text{DR} \leftarrow M[\text{Base } R + \text{SEXT(Offset 6)}] \]

Setcc

Example:

0110 001 010 011101

Opcode
(LDR)
* STR (store, base register + offset mode):

\[ M[Base + \text{SEXT}(Offset 6)] \leftarrow SR \]

Example:

```
0 1 1 1 0 0 1 0 1 0 0 1 0 1 1 0 1
```

Opcode
(STR)
* LDI (load, indirect mode):

\[
\begin{align*}
\text{DR} &\leftarrow M[M[\text{PC} + \text{SEXT}(\text{PC}_{\text{offset9}})]] \\
\text{Setcc}
\end{align*}
\]

Example:

1010 011 111001100

Opcode
(LDI)
* STI (store, indirect mode):

\[ M[M[PC + SEXT(PC + offset9)]] \leftarrow SR \]

Example:

1011 011 111001100

Opcodes
(STI)
* LEA (load effective address):

$$\text{DR} \leftarrow \text{PC} + \text{SEXT (PC offset 9)}$$

Set cc

Example:
1110 101 11111101

 Opcode
 (LEA)