Assignment 2

1. What general categories of functions are specified by computer instructions?

Answer:

Processor-memory: Data may be transferred from processor to memory or from memory to processor.

Processor-I/O: Data may be transferred to or from a peripheral device by transferring between the processor and an I/O module.

Data processing: The processor may perform some arithmetic or logic operation on data.

Control: An instruction may specify that the sequence of execution be altered.

2. The hypothetical machine of Figure 1 also has two I/O instructions:

0011 Load AC from I/O

0111 Store AC to I/O

In these cases, the 12-bit address identifies a particular I/O device. Show the program execution (using the format of Figure 2) for the following program:

1. Load AC from device 5.
2. Add contents of memory location 940.
3. Store AC to device 6.

Assume that the next value retrieved from device 5 is 3 and that location 940 contains a value of 2.

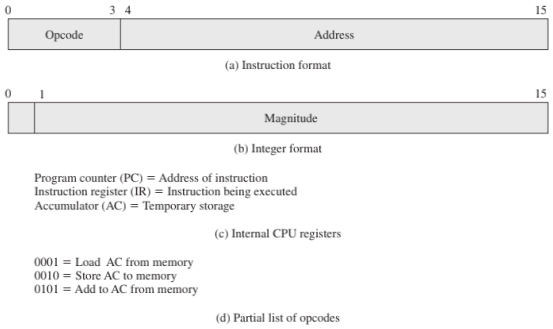

Figure 1. Characteristics of a Hypothetical Machine

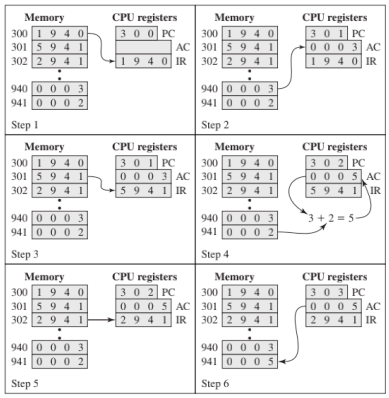

Figure 2. Example of Program Execution (contents of memory and registers in hexadecimal)

Answer:

Numbers are represented in hexaecimal

Assume that device 5's location is 005 and device 6's location is 006

Assume PC=400

400:3005 401:5940 402:7006

Action:

$3005 \rightarrow IR$

$3 \rightarrow AC$

$5940 \rightarrow IR$

$3 + 2 = 5 \rightarrow AC$

$7006 \rightarrow IR$

$AC \rightarrow 006$

3. A two-way set-associative cache has lines of 16 bytes and a total size of 8 Kbytes. The 64-Mbyte main memory is byte addressable. Show the format of main memory addresses.

Answer:

Cache: total 8KB(2^{13}Bytes)

2^4Bytes	2^4Bytes
…	…
2^4Bytes	2^4Bytes

For a two-way set-associative cache, each set has two lines, one of each is 16Bytes(2^4Bytes).
So, each set has the size of $2*2^4=2^5$Bytes.
Therefore, 2^{13}Bytes/2^5Bytes =2^8 sets in total, require 8 digits.

Main Memory: total 64MB(2^{26}Bytes)
And in main memory, it should be separated to blocks according to the number of sets. And each line has the size of 2^4Bytes
So, there are 2^{26}Bytes/2^4Bytes/2^8=2^{14} tags in total, require 14 digits to rep tags.
And there are 26-8-14=4 digits for words.

In all :

Tag:14	Set:8	Word:4

4. Suppose an 8-bit data word stored in memory is 11000010. Using the Hamming algorithm, determine what check bits would be stored in memory with the data word.
Show how you got your answer.

Answer:

$2^{k-1} \geq 8+k$

K=4

Position	12	11	10	9	8	7	6	5	4	3	2	1
Data bit	D8	D7	D6	D5		D4	D3	D2		D1		
Check bit					C8				C4		C2	C1
Data	1	1	0	0		0	0	1		0		
C1		1		0		0		1		0		0
C2		1	0			0	0			0	1	
C3	1					0	0	1	0			
C4	1	1	0	0	0							

C1= D1 ⊕ D2 ⊕ D4 ⊕ D5 ⊕ D7=0 ⊕ 1 ⊕ 0 ⊕ 0 ⊕ 1=0
C2= D1 ⊕ D3 ⊕ D4 ⊕ D6 ⊕ D7=0 ⊕ 0 ⊕ 0 ⊕ 0 ⊕ 1=1
C3= D2 ⊕ D3 ⊕ D4 ⊕ D8=1 ⊕ 0 ⊕ 0 ⊕ 1=0
C4= D5 ⊕ D6 ⊕ D7 ⊕ D8=0 ⊕ 0 ⊕ 1 ⊕ 1=0

Therefore, check bits=0010