**Chapter 4**

**4.5** The following table represents a small memory. Refer to this table for the following questions.

|  |  |
| --- | --- |
| Address | Data |
| 0000 | 0001 1110 0100 0011 |
| 0001 | 1111 0000 0010 0101 |
| 0010 | 0110 1111 0000 0001 |
| 0011 | 0000 0000 0000 0000 |
| 0100 | 0000 0000 0110 0101 |
| 0101 | 0000 0000 0000 0110 |
| 0110 | 1111 1110 1101 0011 |
| 0111 | 0000 0110 1101 1001 |

1. What binary value does location 3 contains? Location 6?

Location 3 (0011) contains 0000 0000 0000 0000; Location 6 (0110) contains 1111 1110 1101 0011;

(b) The binary value within each location can be interpreted in many ways. We have seen that binary values can represent unsigned numbers, 2’s complement signed numbers, floating point numbers, and so forth.

(1) Interpret location 0 and location 1 as 2's Complement integers.

Location 0 (0000) = 7747; Location 1 (0001) = -4059;

(2) Interpret location 4 as an ASCII value.

Location 4 (0100) = e;

(3) Interpret locations 6 and 7 as an IEEE floating Point number.

Locations 6 contains number [15:0]. Location 7 contains number [31:16].

0000 0110 1101 1001 1111 1110 1101 0011

0 00000110 1101100111111110111010011

= 1.10110011111111011010011 x 2 114 = 8.2\*10^-35

(4) Interpret location 0 and location 1 as unsigned interges.

Location (0000) = 7747; Location 1 (0001) = 61477;

(c) In the von Neumann model, the contents of a memory location can also be an instruction. If the binary pattern in location 0 were interpreted as an instruction, what instruction would it represent?

ADD R7, R1, R3;

(d) A binary value can also be interpreted as a memory address. Say the value stored in location 5 is a memory address. To which does it refer? What binary value does that location contain?

M[0101] = 0110; M[0110] = 1111 1110 1101 0011;

**4.7** Suppose a 32-bit instruction takes the following format:

|  |  |  |  |
| --- | --- | --- | --- |
| OPCODE | SR | DR | IMM |

If there are 60 opcodes and 32 registers, what is the range of values that can be represented by the immediate (IMM)? Assume IMM is a 2's complement value

60 opcodes = 6 bits; 32 registers = 5 bits; IMM = 32-6-10 = 16;

IMM is -215 to 214 or -32768 to 37267

**4.8** Suppose a 32-bit instruction takes the following format:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| OPCODE | DR | SR1 | SR2 | IMM |

If there are 225 opcodes and 120 registers

1. What is the minimum number of bits required to represent the OPCODE?

225 opcodes = 8 bits;

1. What is the minimum number of bits required to represent the destination Register (DR)?

120 registers = 7 bits;

1. What is the maximum number of unused bits in the instruction encoding?

32 – (7\*3) – 8 = 3 bits;