



The Islamic University of Gaza
Faculty of Engineering
Department of Computer Engineering



LCOM 3010 - Computer Architecture

Lab 3

Memory

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Introduction

What is Memory?

Memory is the electronic components that store data and instructions that the computer's central processing unit (CPU) can access quickly. When a computer runs a program, it reads data and instructions from the program and stores them temporarily in memory for fast access by the CPU.

Note: Access will take the same time regardless of the location

There are two primary types of memory in a computer:

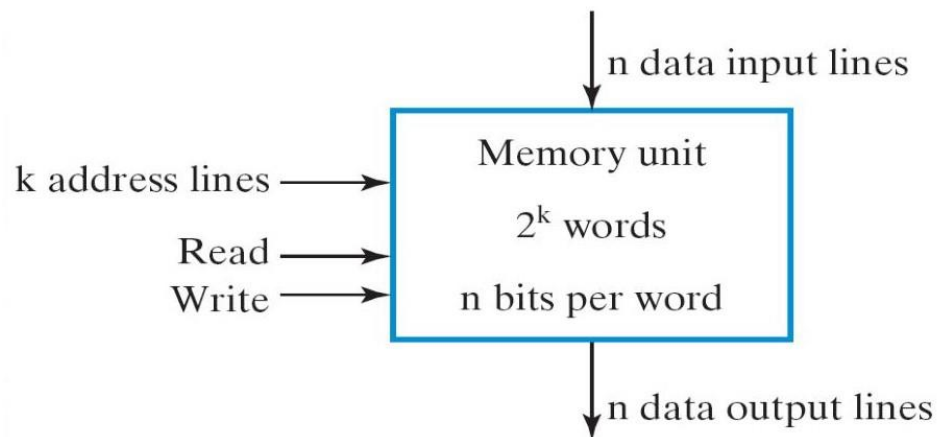
1. **Random Access Memory (RAM):** RAM is the main memory in a computer, and it is volatile, meaning that when the computer is turned off, the data stored in RAM is lost. RAM is used to store data and instructions that the CPU is currently using or will need to use soon. The more RAM a computer has, the more programs it can run simultaneously, and the faster it can process data.
2. **Read-Only Memory (ROM):** ROM is non-volatile memory that is used to store instructions that the computer needs to start up, such as the BIOS (Basic Input/Output System) or UEFI (Unified Extensible Firmware Interface). Unlike RAM, ROM retains its data even when the computer is turned off.

Memories are made up of registers. Each register in the memory is one storage location. The storage location is also called a memory location. Memory locations are identified using Address. The total number of bits a memory can store is its capacity.

A storage element is called a Cell. Each register is made up of a storage element in which one bit of data is stored. The data in a memory are stored and retrieved by the process called writing and reading respectively.

Random Access Memory (RAM)

A memory unit consists of data lines, address selection lines, and control lines that specify the direction of transfer. The block diagram of a memory unit is shown below:



The Write input causes binary data to be transferred into the memory, and the Read input causes binary data to be transferred out of memory.

Example of memory content

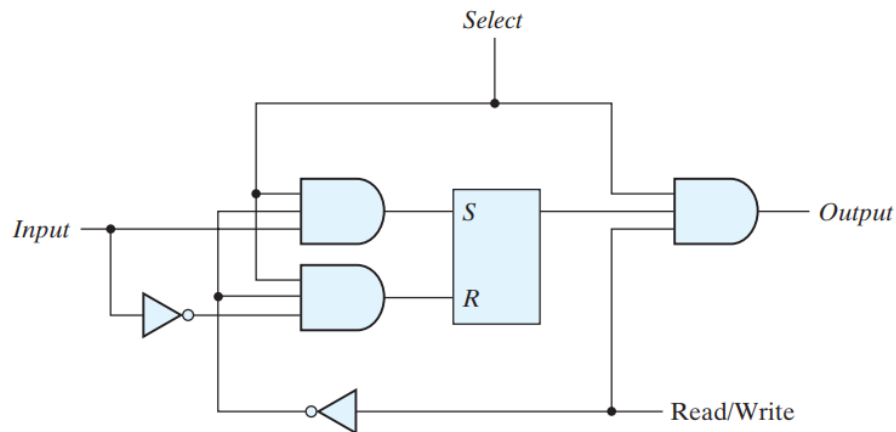
<u>Memory address</u>		<u>Memory contents</u>
<u>Binary</u>	<u>Decimal</u>	
0000000000	0	10110101 01011100
0000000001	1	10101011 10001001
0000000010	2	00001101 01000110
	.	.
	.	.
	.	.
	.	.
	.	.
1111111101	1021	10011101 00010101
1111111110	1022	00001101 00011110
1111111111	1023	11011110 00100100

A word is a group of bits where a memory unit stores binary information. A word with a group of 8 bits is called a byte.

Internal Construction: The internal construction of a random-access memory of m words with n bits per word consists of $m \cdot n$ binary storage cells and associated decoding circuits for selecting individual words. The binary cell is the basic building block of a memory unit.

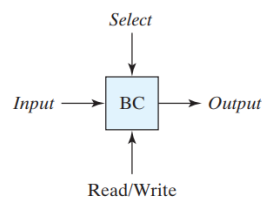
RAM Internal Construction

The binary storage cell is the basic building block of a memory unit. The equivalent logic of a binary cell that stores one bit of information is shown in Fig.



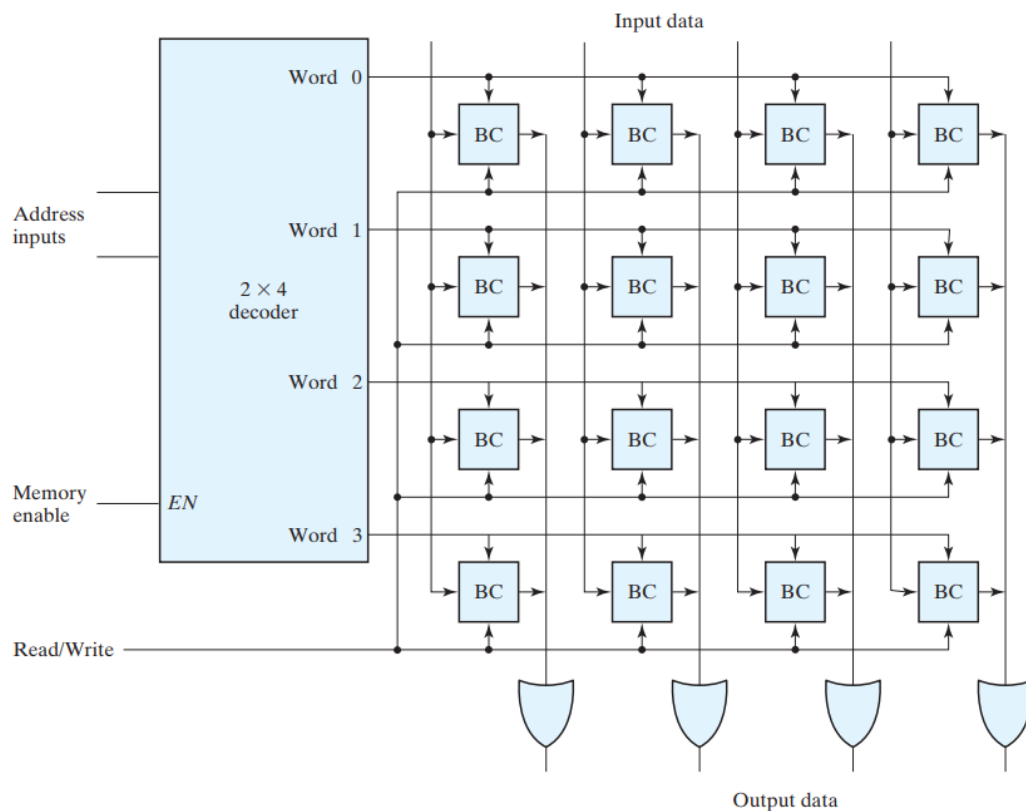
The binary cell has three inputs and one output. The select input enables the cell for reading or writing and the read/write input determines the cell operation when it is selected. A 1 in the read/write input provides the read operation by forming a path from the flip-flop to the output terminal. A 0 in the read/write input provides the write operation by forming a path from the input terminal to the flip-flop.

The small blocks labeled BC represent the binary cell with its three inputs and one output, as specified in Fig.



Design of a 4X4 RAM

A memory with four words needs two address lines. The two address inputs go through a 2×4 decoder to select one of the four words. The decoder is enabled with the memory-enable input. When the memory enable is 0, all outputs of the decoder are 0 and none of the memory words are selected. With the memory select at 1, one of the four words is selected, dictated by the value in the two address lines. Once a word has been selected, the read/write input determines the operation. During the read operation, the four bits of the selected word go through OR gates to the output terminals. During the write operation, the data available in the input lines are transferred into the four binary cells of the selected word. The binary cells that are not selected are disabled, and their previous binary values remain unchanged. When the memory select input that goes into the decoder is equal to 0, none of the words are selected and the contents of all cells remain unchanged regardless of the value of the read/write input.



LAB TASK

Use logisim program to build and simulate the ram cell then use it to design a 4 * 4 RAM memory.