Computer Architecture

Lecture 2
Registers and Memories

Asst. Lect.:Noor H. Hassoon

Registers and Memories

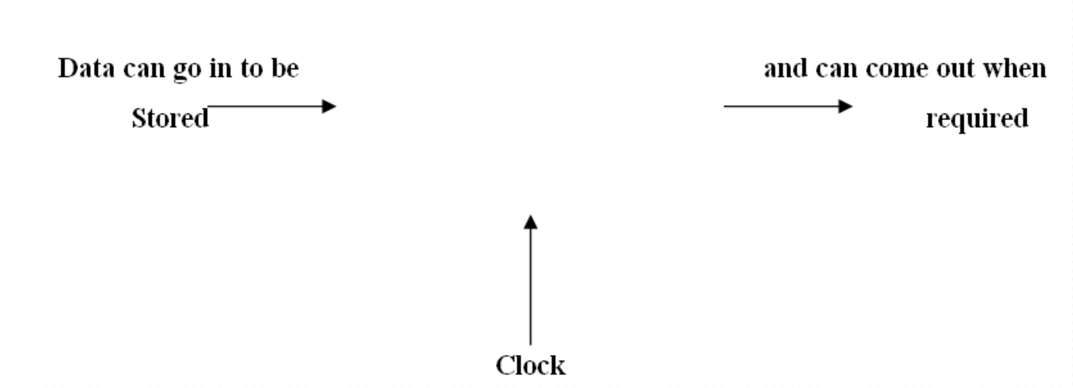
- The logic gates occur in their millions in microprocessors and in the surrounding circuitry. They are to be found in all microprocessors from the oldest and simplest.

- When logic gates are used in a microprocessor, they are usually grouped together into circuits, called flip-flops, each one being able to store a single binary digit.

Registers and Memories

A flip-flop or bistable:

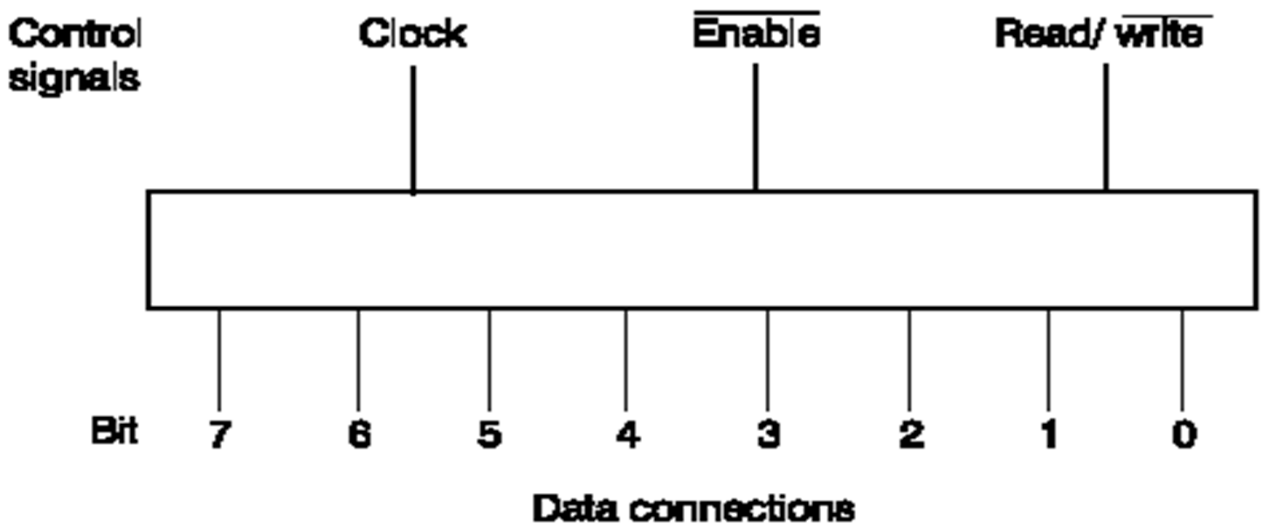
- A flip-flop or bistable is a circuit that can store a single binary bit either 0 or 1. One useful characteristic of the flip-flop is that it can only have an output of 0 or 1. It cannot hover somewhere in between. The flip-flop is shown in following figure. The purpose of the clock input is to tell the flip-flop when to accept the new input level.



Registers and Memories

A register:

- A register is just a collection of flip-flops. A flip-flop can only store one bit so to handle 32 bits at a time we would need 32 flip-flops and would refer to this as a 32-bit register. To save space, following figure shows an 8-bit register.



Registers and Memories

- The register has two distinct groups of connections: the data bits 0 to 7 and the control signals. The data connections or data lines carry the binary levels in or out of the register.

- The number of data lines determines the size of the register so a 64-bit register would have 64 data connections.

Registers and Memories

What are registers for?

- Registers are storage areas inside the microprocessor. Almost the whole of the microprocessor is made of registers. They store the data that is going to be used, they store the instructions that are to be used and they store the results obtained.

- Nearly all registers involve tri-state buffers to control the direction of data flow.

Registers and Memories

How long can it be stored?

- It will be stored until the power supplies are removed ‘either’ by an equipment fault or, more usually by the system being switched off. The data does not deteriorate in storage.

Registers and Memories

Memories:

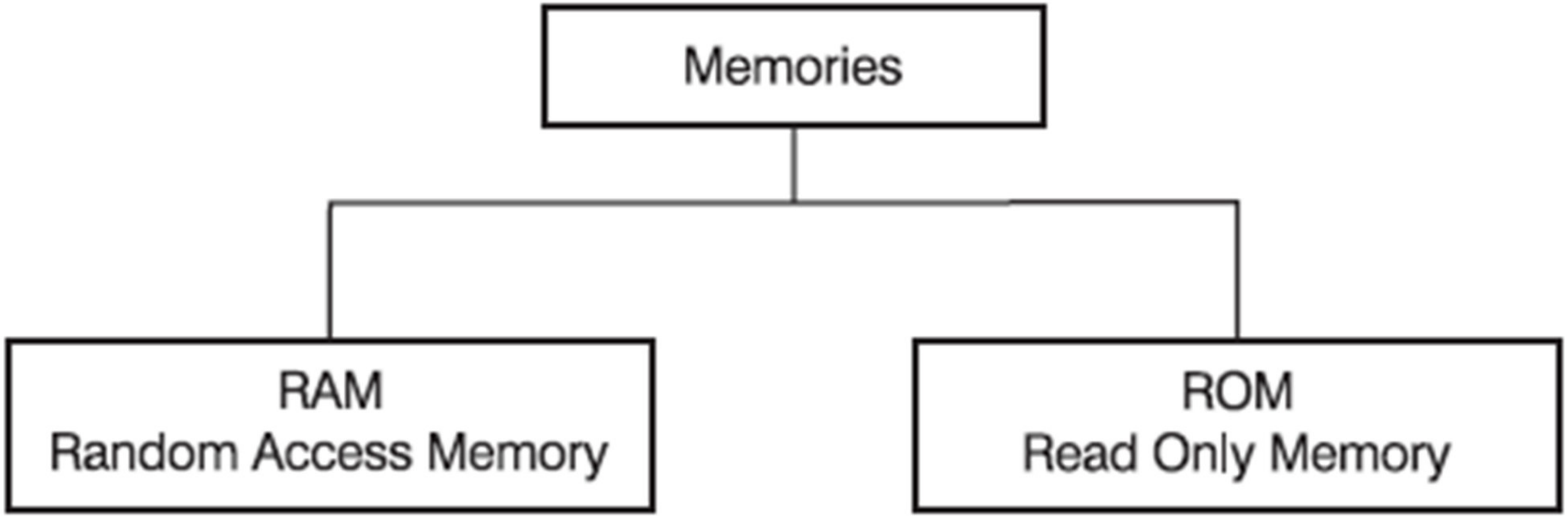
- The function of a memory is to store information almost the same as we said for the register. Generally, a register lives within the microprocessor and stores small quantities of data for immediate use and it can do useful little tricks like shift and rotate. **A memory is designed for bulk storage of data.**

Registers and Memories

- Some types can remember the data even when the power is switched off. The ability to remember data after the power is switched off is the dividing line between the two main types of memory.

- If it loses its data when the power is switched off, then we call the memory RAM or volatile memory. If it can hold on to the data without power, we call it ROM or non-volatile memory (volatile means able to evaporate). This is seen in following figure.

Registers and Memories



Registers and Memories

Random Access Memory (RAM) :

- It is used to store user programs and data, and can be altered at any time, i.e. temporary storage. The information stored in RAM or RWM can be easily read and altered by the CPU. The contents (data or programs) stored is lost if power supply to this chip is turned off.

Registers and Memories

- The letters RAM stands for Random Access Memory. The memory comes in an integrated circuit looking like a small microprocessor and is usually called a memory chip.

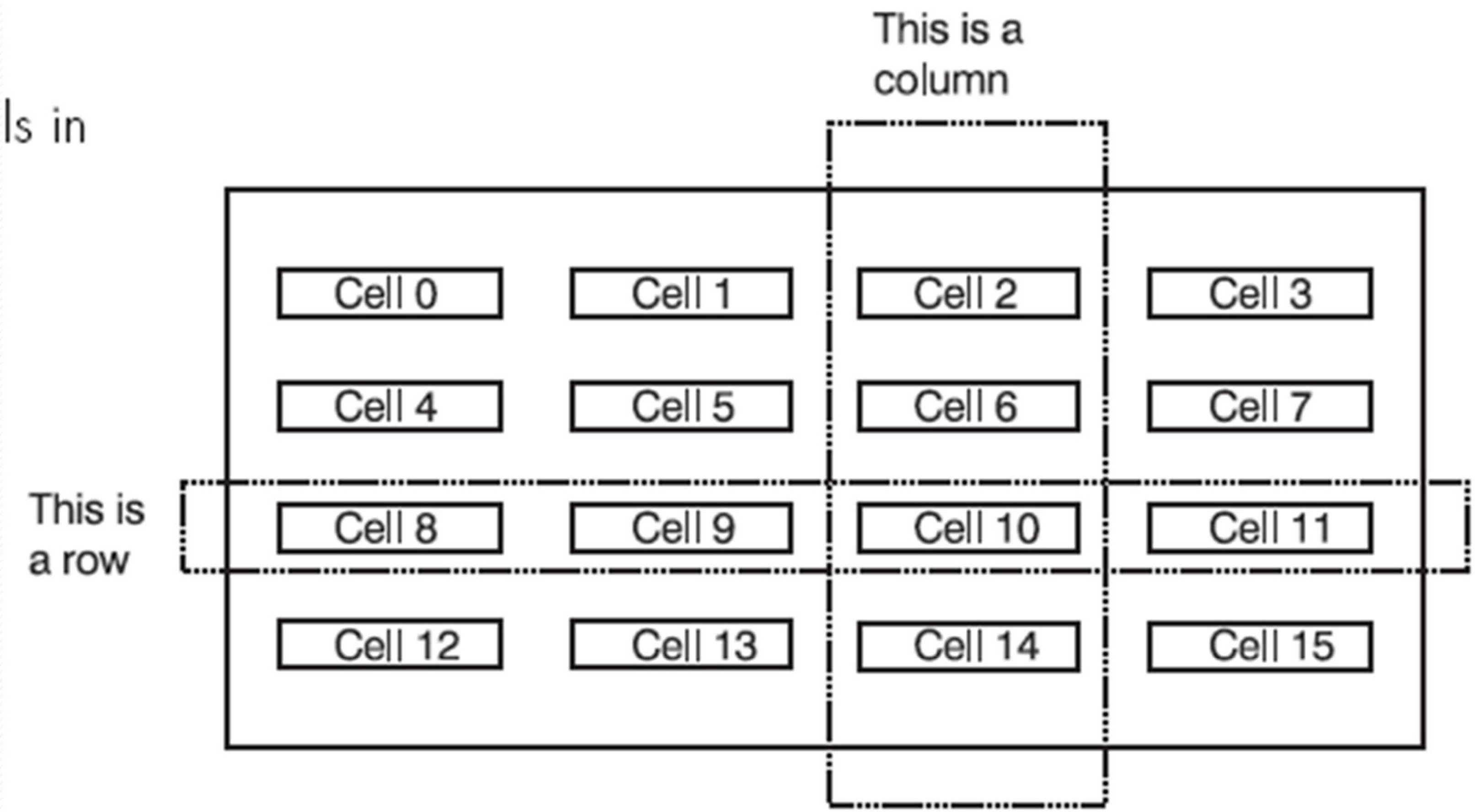
- Inside, there are a large number of registers, hundreds, thousands, millions depending on the size of the memory.

Registers and Memories

- Incidentally, when we are referring to memories, we use the word ‘cell’ instead of register even though they are the same thing.

- So, each of the internal cells may have 4, 8, 16, 32, or 64 bits stored in flip-flops. Following figure shows the register layout in a very small memory containing only 16 cells or locations, each of which can hold 4 bits and is given a memory number or address.

Registers and Memories



The cells or 'memory locations' are numbered from 0 to 15.
Each holds binary data – anywhere between 1 and 8 bits in each.

Registers and Memories

This RAM word:

- In prehistoric computing days, the memory would be loaded in order. The first group of bits would go into location 0, the next would go into location 2, then location 3 and so on rather like a shift register.

- This meant that the time to load or recover the information would increase as we started to fill the memory and have to move further down the memory.

Registers and Memories

- This was called sequential access memory (or serial access memory), abbreviated to SAM. This was OK when a large computer may hold 256 bits of information but would be impossibly slow if we tried this trick with a gigabyte.

- To overcome this problem, we developed a way to access any memory location in the same amount of time regardless of where in the memory it happens to be stored.

Registers and Memories

- This system was called random access memory or RAM. All memory, whether volatile or non-volatile is now designed as random access memory so it would be much better to divide the two types of memory into read/write and read only memory. But it won't happen, RAM is too firmly entrenched.

Registers and Memories

Accessing memory:

- Each location in a memory is given a number, called an address. In previous figure, the 16 locations of memory would be numbered from 0 to 15, or in binary 0000_11112. The cells are formed into a rectangular layout, in this case a (4*4) square with four columns and four rows.

Registers and Memories

- To use a cell, the row containing the cell must be selected and the column containing the cell must also be activated. The shaded cell in following figure has the address 0110 which means that it is in row 01 and in column 10.

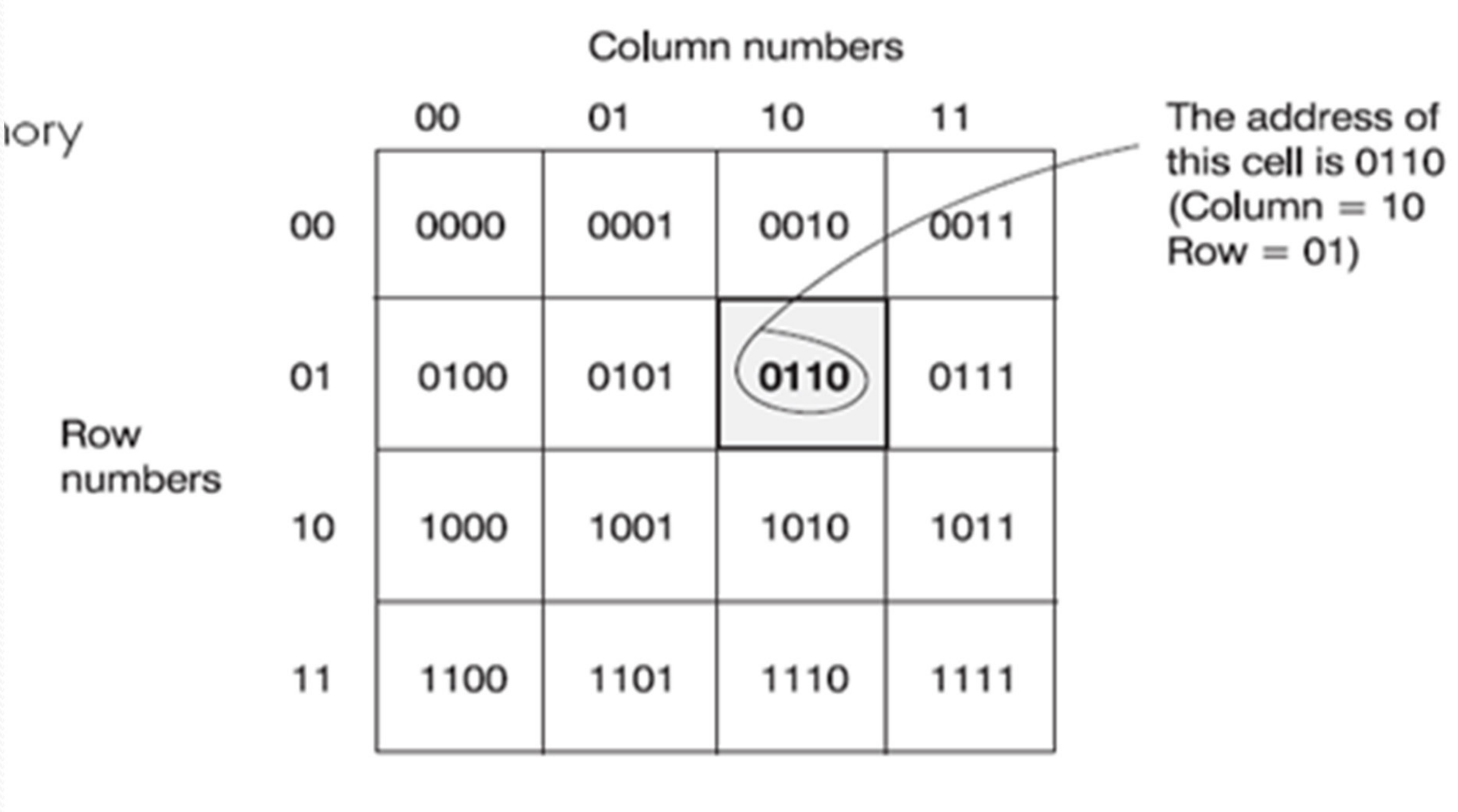
- To access this cell we need to apply the binary address to the row and column decoders.

Registers and Memories

- When the address 0110 is applied, the first half of the address, 01, is applied to the row decoder and the second half of the address is applied to the column decoder.

- A decoder circuit is a small logic circuit that, when fed with the address of the location, is able to switch on the appropriate row and column.

Registers and Memories



Registers and Memories

- The maximum number of locations that can be addressed will depend on the number of bits in the address. We have already seen that a 4-bit address can access 16 locations.

- This was because 24 = 16, so, generally 2n = number of locations where n is the number of bits in the address. To take a more realistic example, if we had 20 address lines we would have 220 = 1048576 or 1Meg locations.

The End