Basic Micro-computer

- **Microprocessor** ($\mu P$)
  - Input:
    - Address Bus
    - Data Bus
    - Control Bus
  - Output:
    - Address Bus
    - Data Bus
    - Control Bus

- **RAM** (Random Access Memory)
  - Input:
    - Address Bus
    - Data Bus
    - Control Bus
  - Output:
    - Address Bus
    - Data Bus
    - Control Bus

- **ROM** (Read Only Memory)
  - Input:
    - Address Bus
    - Data Bus
    - Control Bus
  - Output:
    - Address Bus
    - Data Bus
    - Control Bus

- **I/O Interface**
  - Input:
    - Address Bus
    - Data Bus
    - Control Bus
  - Output:
    - Address Bus
    - Data Bus
    - Control Bus

- **I/O Device**

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**Digital Fundamentals**

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• MEMORY CONCEPTS
  • Data are stored in a memory by a process called *writing* and are retrieved from the memory by a process called *reading*.
  • Memories are made up of storage locations in which data can be stored.
  • Each location is identified by an address.
  • the total number of bits that a memory can store is its *capacity*.
  • one *byte* equals 8-bit
  • Memories are made up of storage elements (flip-flops, capacitors, magnetic)
  • A storage element is called a *cell*.
• Type of semiconductor Memories
  • ROM (Read Only Memory) – nonvolatile – data can be read NOT write.
  • RAM (Random access memory) both Read AND Write operation and is volatile memories, so data are lost if the power is removed.

• The ROM family.
  • PROM (Programmable Read Only Memory) data are electrically stored by the user with the aid of specialized equipment.
  • EPROM (Electrically programmable ROM) – electrically programmable by the user and can be erased either by exposure to ultraviolet light or electrical means.
  • EEPROM (Electrically erasable PROM).

• The RAM family
  • Static RAM (the storage elements used are latch (flip-flop)) – data can be stored for an indefinite period of time as long as power is on.
  • Dynamic RAM (data are stored on capacitors) – required periodic recharging (refreshing) to retain the data.

• Words and bytes
  • a complete unit of binary information or data is called a word.
  • eight-bit groups called bytes
• **Capacity**
  - A way of specifying how many bits can be stored in a particular memory device.
  - 1K to represent 1024 words.
  - *Example*: a certain semiconductor memory chip is specified as 2K X 8. How many words can be stored on this chip? How many total bits can this chip store?

• **Address**: a number that identifies the location of a word in memory
• **Read operation**: a binary word stored in a specific memory location (address) is sensed and then transferred to another location.
• **Write operation**: a new word is placed into a particular memory location. It is also referred to as a store operation.
• **Access time**: a mount of time required to perform a read operation
• **Cycle time**: a mount of time required for the memory to perform a read or write operation and then return to its original state ready for the next command.

• *Example*: A certain memory has a capacity of 4K X 8.
  a) How many data inputs/outputs lines does it have?
  b) How many address lines does it have?
  c) What is its capacity in bytes?
FIGURE 10-31 Basic read/write cycle timing for the static RAM in

FIGURE 11.11 To program a 2716, the desired data are applied to the data pins, and a program pulse is applied to $\overline{CE}$. 