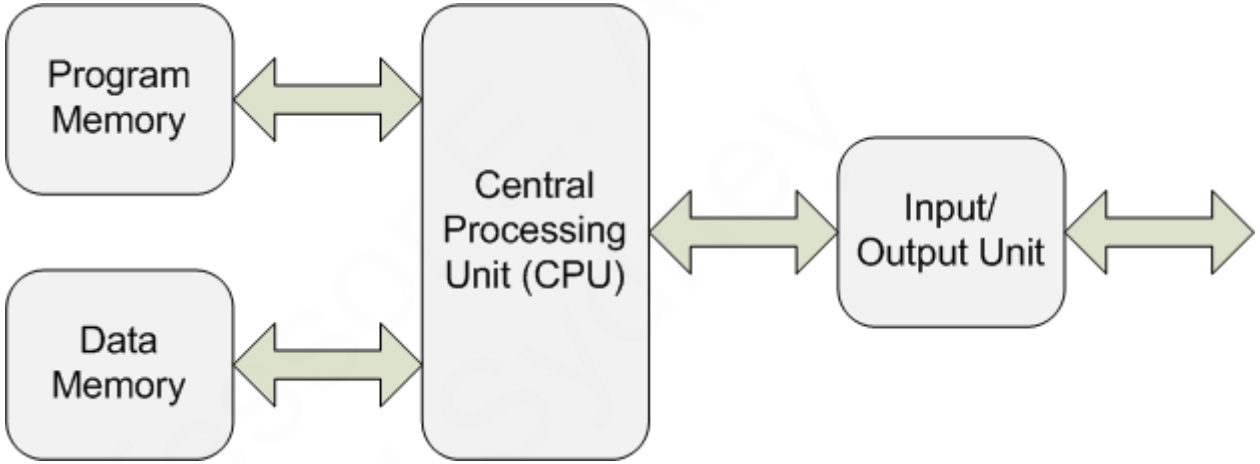
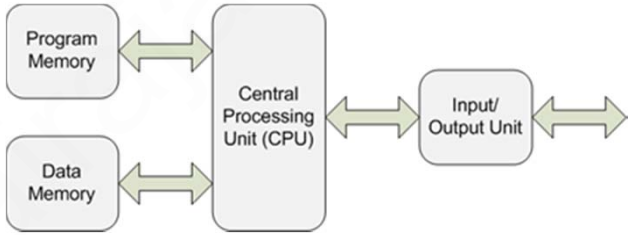
The Computer

The basic components of a computer are:

- Input /Output Unit
- Memory Unit (Program memory and Data Memory)
- Central Processing Unit consists of Arithmetic Logic Unit & Control Unit



Input/Output and Memory Units



Input /Output Unit:

- *Input Unit* accepts the instructions and data from the outside world and converts them in computer acceptable form for further processing by the CPU.

- *Output unit* accepts the result produced by the CPU and converts the result into human readable form and supplies to the outside world.

Memory Units: There are two memory types:

- ***Volatile memory*** – This memory chip loses its stored value when power is removed and it is normally used as temporary data storage (temporarily storing results of addition operation). This memory is called *Random Access Memory* (RAM) i.e data memory

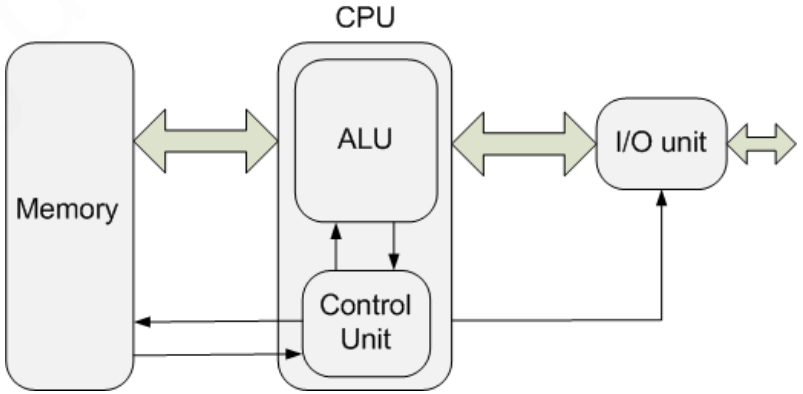
- ***Non-Volatile memory*** – This memory chip retains its stored value when power is removed and is normally used to hold computer program. This memory is called Read Only Memory (ROM) i.e program memory

Central Processing Unit

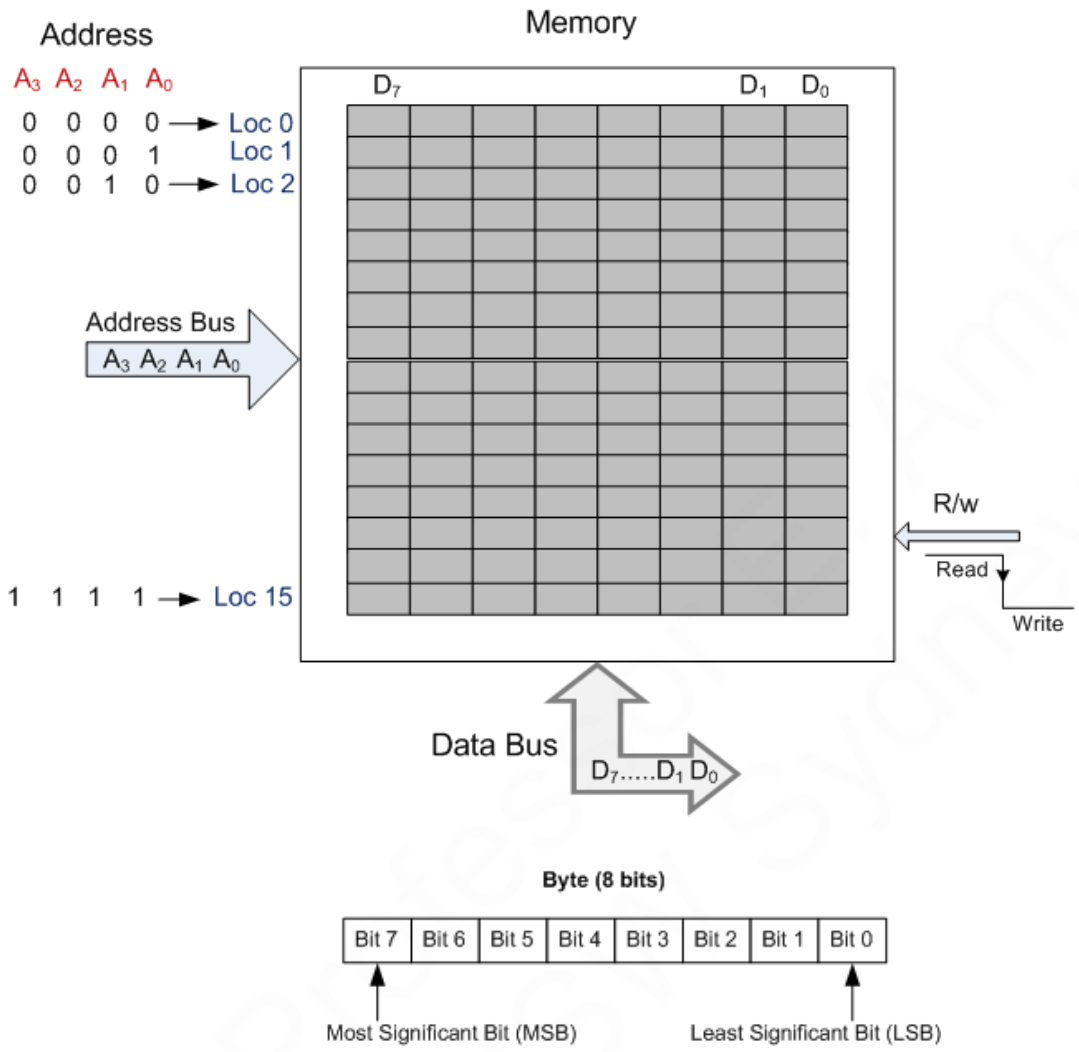
The Central Processing Unit (CPU) is the brain of the computer comprising:

- ❑ Arithmetic Logic Unit (ALU)
- ❑ Control Unit

- ➢ The Arithmetic Logic Unit (ALU) is responsible for performing arithmetical (eg. addition , subtraction etc) and logical (AND, OR, XOR etc) operations.
- ➢ The **control unit** coordinates the components of a computer system. It interprets the instructions in memory and causes them to be executed. It directs the operation of the other units by providing timing and control signals. It directs the flow of data between the Central Processing Unit (CPU) and the other devices.



Memory Addressing



- Memories are generally arranged in the form of rows and columns
- A memory consists of many memory locations, each having a physical address.
- Addressing is the process of selecting a row in a memory to be written into or to be read from.
- With the use of a 4-bit addressing, 16 locations (= 2^4-1) can be to addressed.
- 16-bit addressing provides 64 KB of memory [i.e. 65535 locations (= 2^{16}-1)]

ROMs,PROMS,EPROMs and EEPROMs

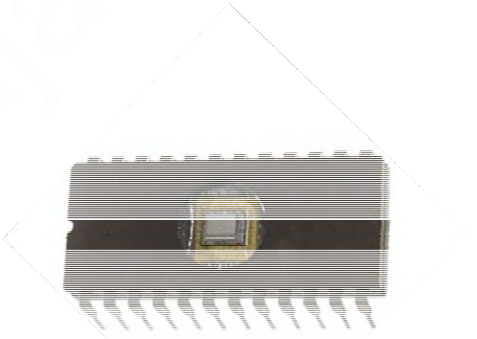
- ✓ **ROM** (Read Only Memory) is fabricated by the manufacturer with the desired data permanently stored in it and thus can never be modified.

- ✓ **PROM** (Programmable Read Only Memory) is a type of ROM that is programmed after the memory is constructed.
  - Such PROMs are used to store programs permanently.
  - Standard PROM can only be programmed once.
  - This is because PROM chips are manufactured with a series of fuses and the chip is programmed by burning fuses, which is an irreversible process.

Programmable Read Only Memory

ROMs,PROMS,EPROMs and EEPROMs

- ✓ **EPROM** (Erasable Programmable Read Only Memory) is a type of memory uses floating-gate transistors and can be erased by strong ultraviolet light.
  - EPROMs are easily recognizable by the transparent window in the top of the package, which permits exposure to UV light during erasing.
  - EPROMS must be removed from the circuit for erasing and programming.
- ✓ **EEPROM** (electrically erasable programmable read-only memory) can be erased and reprogrammed (written to) repeatedly through the application of higher than the normal electrical voltage.
  - Unlike EPROMS, EEPROMs can be programmed and erased in-circuit.
  - The number of times EEPROMS could be reprogrammed is in the order of a million write operations.



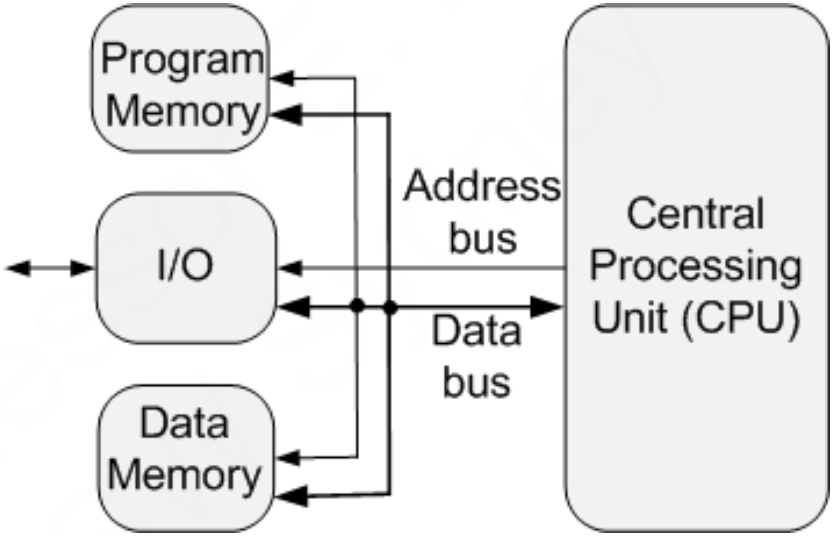
Erasable Programmable Read Only Memory

ROMs,PROMS,EPROMs and EEPROMs

- ✓ **Flash memory (**non-volatile**)** is a special form of EEPROM which uses normal PC voltages for erasure and reprogramming.
- ✓ Flash erases whole blocks of data at a time, rather than on a bit-by-bit level, as conventional EEPROM does
- ✓ The size and complexity of flash memory varies in devices ranging from USB drives, cameras and smartphones to embedded applications

Von-Neumann vs Harvard Architecture

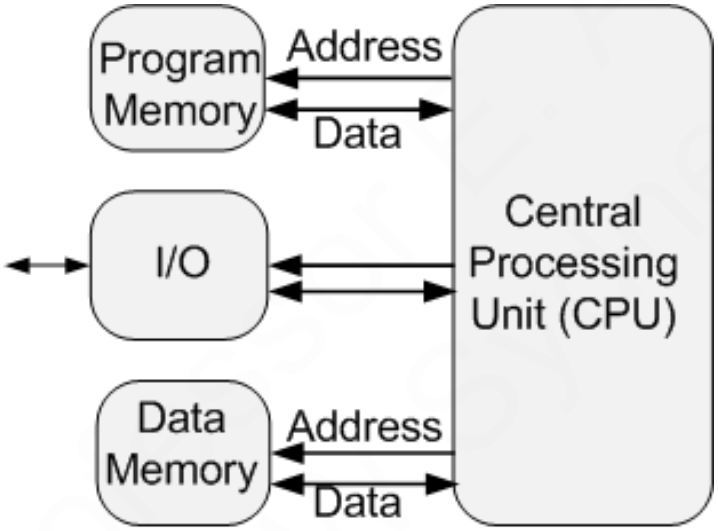
- **Von-Neumann Architecture** has just one address (unidirectional) bus and one data bus (bidirectional) and the same busses serve both program and data memories and the input output may also be connected in this way to behave like a memory.
- The CPU can access program memory or data memory, but not both at the same time since they use the same bus system.
- Sharing become difficult , hence the structure is inefficient



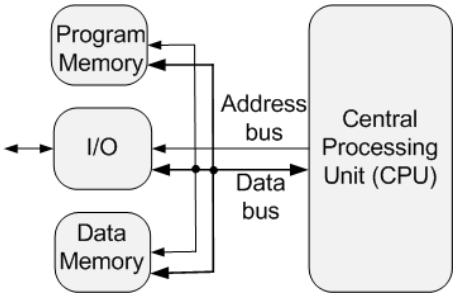
Von-Neumann Architecture

Von-Neumann vs Harvard Architecture

- **Havard Architecture** has two address buses and two data buses, i.e program memory and data memory have their own address and data busses.
- Each can be different in size and the data and program can be accessed simultaneously.
- The input/output is memory mapped, hence it behaves like a memory.



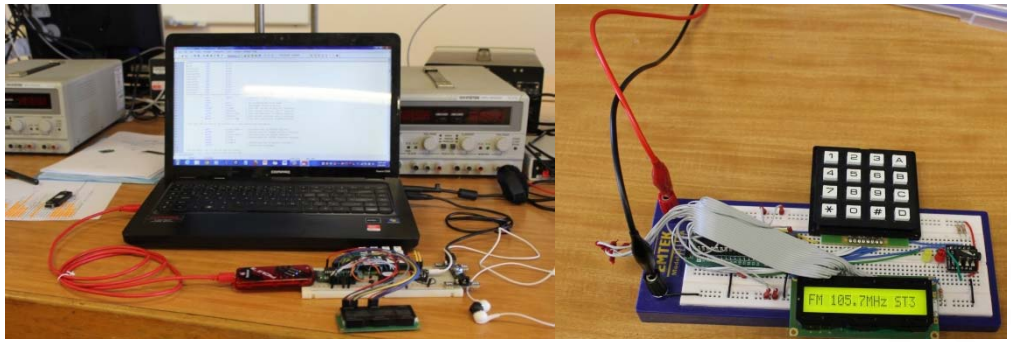
Havard Architecture



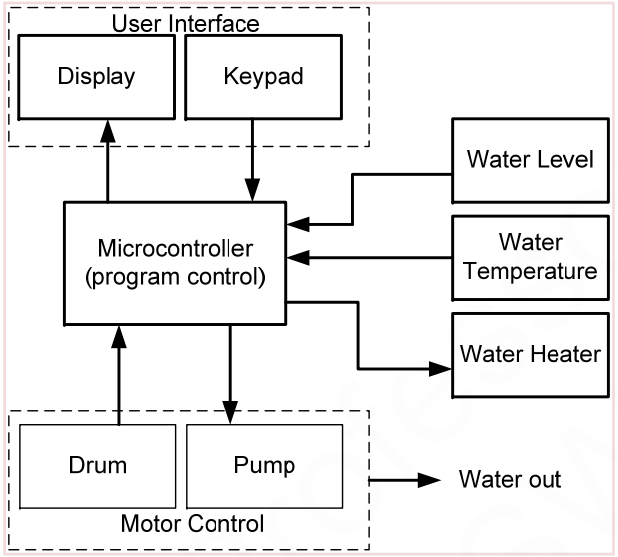
Von-Neumann Architecture

Microcontroller applications

- Example1: A tuneable FM radio with pre-set radio stations using a microcontroller

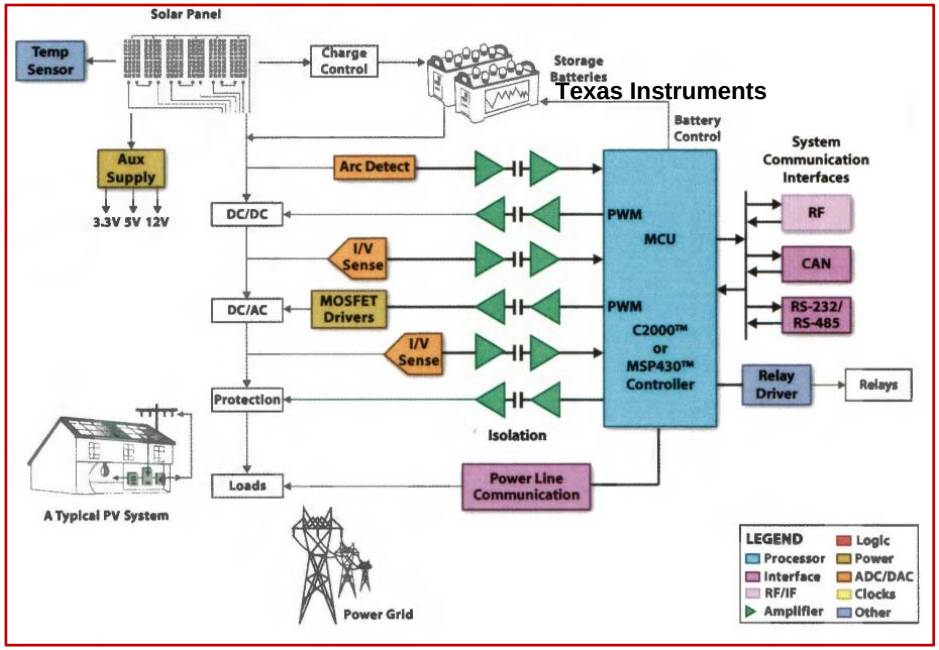


- Example 2: Microcontrollers for Automatic Washing Machines



Washing Machine

- Example 3: Microcontrollers in Solar Applications



Chapter 1a: Exercise1

- Compare the Von Neumann and Harvard architectures and identify their key differences. Use diagrams to illustrate your answer.
- A computer has 256K of EEPROM memory. How many bytes does this represent? How many address lines are required to access one byte at a time?
- What is the meaning of RAM, and what is its primary role?
- A logic analyser is used to check the circuit in figure 1 and it displays the waveforms shown in figure 2. The logic analyser display shows all four data outputs, *Q*0 to *Q*3. The analyser's cursor is placed at position X (fig 2) and all four of the data output lines show a LOW level (zero) output.

  (a) What is wrong, if anything, with the circuit?

  (b) What value is being written into memory location 211(decimal)?