Microprocessor
(Unit-1 :: Lecture – 2)

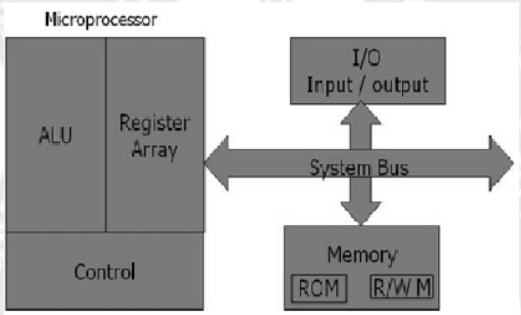
(BEI – I/II & BCT – II/II)

Er. Dinesh Baniya Kshatri
Assistant Professor
Institute of Engineering, Thapathali Campus

Microprocessor Features

- **Cost Effective:**
  - Due to automated mass manufacturing capabilities, microprocessors have become economical
- **Small Dimensions:**
  - Small size and light weight allow microprocessors to be portable
- **Low Power Consumption:**
  - Use of MOS technology has enabled better power efficiency
- **Versatile:**
  - Same chip is usable in many applications by reconfiguring the software
- **Highly Reliable:**
  - Mature manufacturing technology has decreased the failure rate

Microprocessor Based System
(Organization) – [1]



Microprocessor Based System
(Organization) – [2]

- **Microprocessor:**
  - Is a clock driven semiconductor device
  - Consists of electronic logic circuits manufactured by using either a large scale integration (LSI) or very large scale integration (VLSI) technique
  - Can perform various computing functions and make decisions to change the sequence of program execution

Microprocessor Based System (Organization) – [3]

- **Microprocessor Sub-units:**
  - Arithmetic/Logic unit:
    - Performs arithmetic operations such as addition and subtraction as well as logic operations such as AND, OR, and XOR
  - Register Array:
    - Registers are primarily used to store data temporarily during the execution of a program
    - Are accessible to the user through instructions
  - Control Unit:
    - Generates necessary timing and control signals required to carry out various operations

Microprocessor Based System (Organization) – [4]

- **Memory:**
  - Stores instructions and data, and provides that information to the microprocessor whenever necessary
  - To execute programs, the microprocessor reads instructions and data from memory and performs the computing operations in its ALU
  - Results produced from an operation are either transferred to the output section for display or stored in memory for later use

Microprocessor Based System (Organization) – [5]

- **Basic Memory Types:**
  - Read only Memory (ROM):
    - Stores information that do not need frequent alterations
    - Non-volatile memory
    - MROM, PROM, EPROM, EEPROM, FLASH
  - Read/Write Memory (RAM):
    - Stores instructions and data required for program execution
    - Information stored can be read and altered
    - Volatile memory
    - SRAM, DRAM

Microprocessor Based System (Organization) – [6]

- **Input / Output (I/O):**
  - Allows the microprocessor to communicate with the external world
    - Input devices such as keyboards, switches, mouse, joysticks transfer information from the outside world to the microprocessor
    - Output devices transfer information from the microprocessor to the outside world. Examples include devices such as monitors and printers

Microprocessor Based System (Organization) – [7]

- **System Bus:**
  - A communication path between the microprocessor and peripheral devices
  - Consists of a group of wires to carry bits
  - Bits represented as follows in TTL:
    - Logic 0 = Low voltage (around zero volts)
    - Logic 1 = High voltage (around five volts)

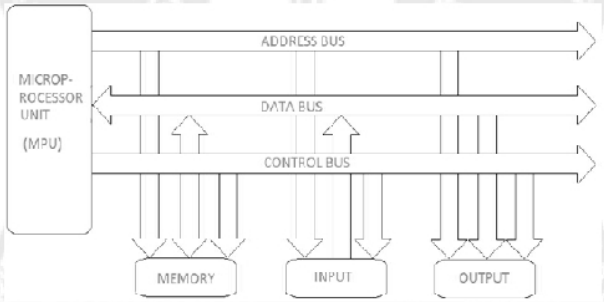
Pop Quiz

- **MOSFET vs. BJT:**
  - Provide their full forms.
  - Name the terminals of the transistors.
  - Name the regions of operation of the transistors.
  - Which transistor switches faster and why?
  - Which transistor consumes less power and why?

System Bus Organization – [1]

- System bus is a common channel through which bits from any source can be transferred to the destination
- Bus lines can be classified into three functional groups:
  - Data Bus
  - Address Bus
  - Control Bus

System Bus Organization – [2]



Systems Bus Organization – [2]

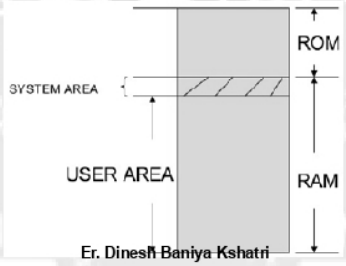
- **Data Bus:**
  - Provides a path for moving data between system modules
  - It is bidirectional:
    - Processor needs data from memory or input devices for processing
    - Processed data needs to be stored back into memory or displayed in output devices
  - Width of data bus determines how much data can be transmitted at one time
    - E.g. A 16-bit data bus can transmit 16 bits of data at once

Systems Bus Organization – [3]

- **Address Bus:**
  - They are used to specify the source / destination of data
  - Data may reside in memory, input, or output port
  - It is unidirectional, supplying addresses from microprocessor to memory, input, or output devices
  - Width of the address bus provides information regarding the size of the memory map of the processor

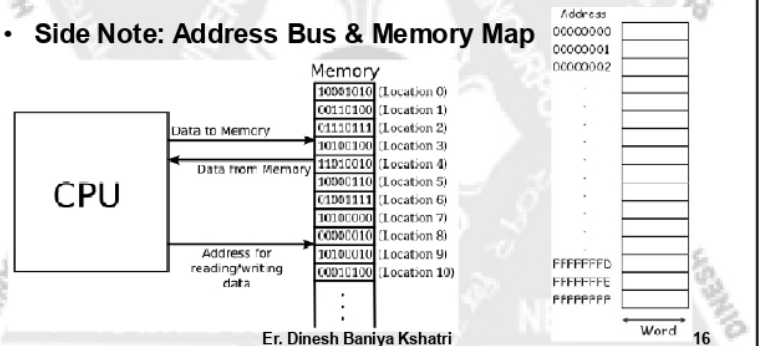
Systems Bus Organization – [4]

- **Side Note: Memory map**
  - It refers to the range of all possible physical memory locations



Systems Bus Organization – [5]

- **Side Note: Address Bus & Memory Map**



Systems Bus Organization – [5]

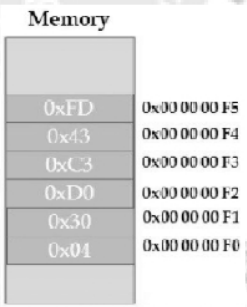
- **Side Note: Address Bus & Memory Map**
  - The size of address bus determines how many unique memory locations can be addressed
  - Examples:
    - A system with 4-bit address bus can address 2^4 = 16 memory locations
    - A system with 16-bit address bus can address 2^{16} = 64K memory locations
    - A system with 20-bit address bus can address 2^{20} = 1M memory locations

Systems Bus Organization – [6]

- **Control Bus:**
  - Carries both command and timing signals
  - Controls all associated peripherals
  - Timing signals synchronize operations
  - Command signals specify operations to be performed
  - Also carries signals that report the status of various devices
  - Examples of control lines include:
    - Memory Read/Write, I/O Read/Write, Bus Request/Grant, clock, Reset, Interrupt Request/Acknowledge

Pop Quiz

- What is the word length in bits?
  - Assume the maximum number that can be stored is FFH
- What are the values of the minimum and maximum memory addresses?
  - Give answer in Hex and Binary
- What should be the size of the address bus?



Stored Program Concept – [1]

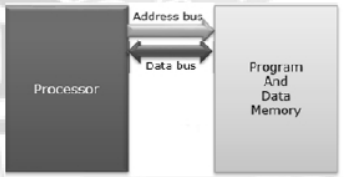
- Concept introduced by John Von Neumann in 1940s
- Represent programs in a suitable form so that they can be stored in memory alongside data
  - Computer programs are a series of instructions that enable a computer to perform a variety of tasks
- The stored program concept allowed the following:
  - Instructions to be stored in memory
  - Instructions to be executed in sequence referencing the data values it needs on which to operate

Stored Program Concept – [2]

- This concept removed the need for humans to manually feed the computer with instructions from an external source such as the following:
  - Sliding Switches, Pressing Buttons, Arranging Jumper Wires
- A computer could get its instructions by automatically reading them from memory:
  - Program can be altered by changing the corresponding memory values

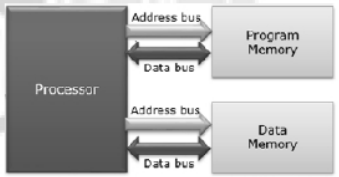
Stored Program Concept – [3]
(Von Neumann / Princeton Architecture)

- In von-Neumann architecture, the same memory is used for storing instructions and data
- Single system bus (same data bus and address bus) used for reading data and instructions from or writing to memory
- Limited processing speed for computers



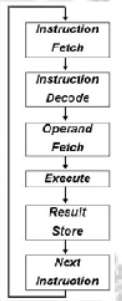
Stored Program Concept – [4]
(Harvard Architecture)

- Harvard architecture consists of separate memory spaces for the programs (instructions) and data
- Each memory space has its own address and data buses
- Instructions and data can be fetched from memory concurrently and provides significant improvement in processing speed



Stored Program Concept – [5]
(Processing Cycle)

- **Fetch Stage**
  - Obtain instruction from memory
- **Decode Stage**
  - Interpret the meaning of an instruction
- **Execute Stage**
  - Evaluate operand address (if required by instruction)
  - Fetch data from memory, port or register (if required by instruction)
  - Carry out operation specified by instruction
- **Write Back / Store Stage**
  - Store the result back to a register or memory



Pop Quiz

- What are punch cards?
- How were punch cards used to supply instructions to early computers (before the stored program concept)?
- What are the disadvantages of using punch cards?