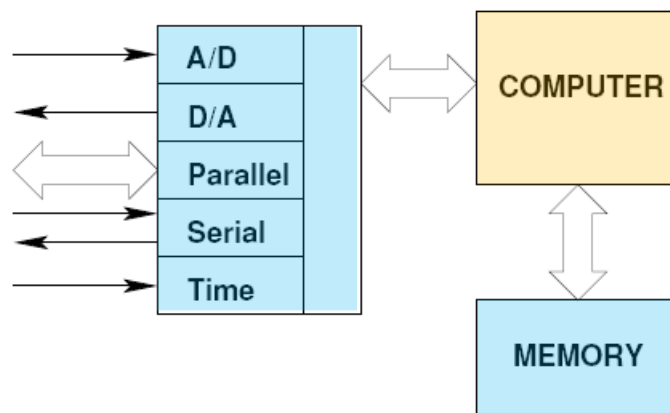
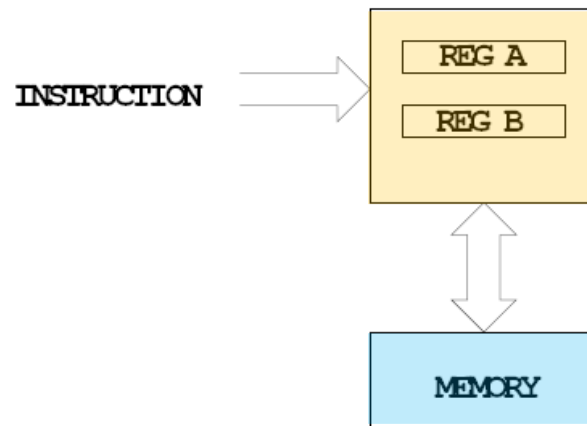


- **Introduction to Microprocessors and Microcontrollers.**
  - Block Diagrams of Simple Microprocessor and Microcontroller
  - Harvard architecture and Princeton architecture microprocessor block diagrams
  - Memory map for a Princeton architecture microprocessor

## **MICROCONTROLLER**

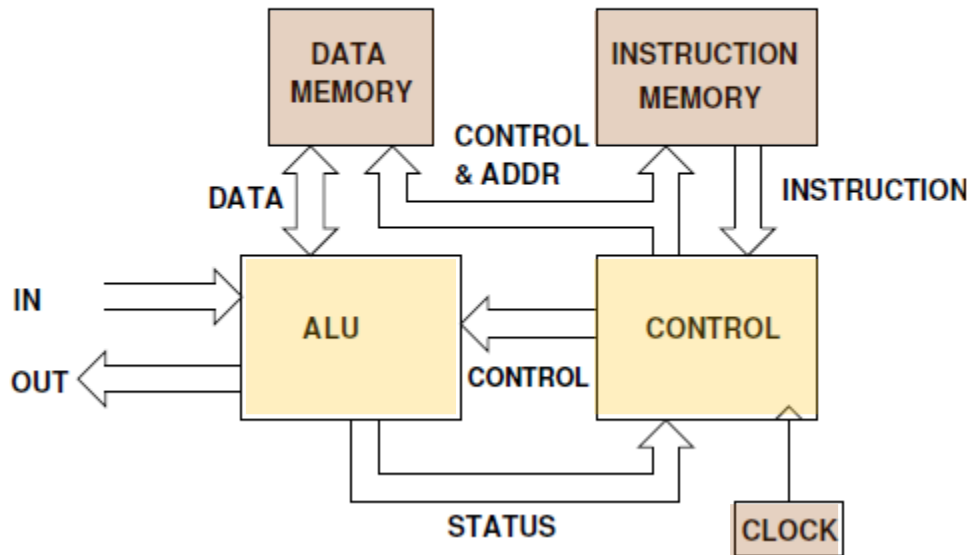


## **SIMPLE MICROPROCESSOR**

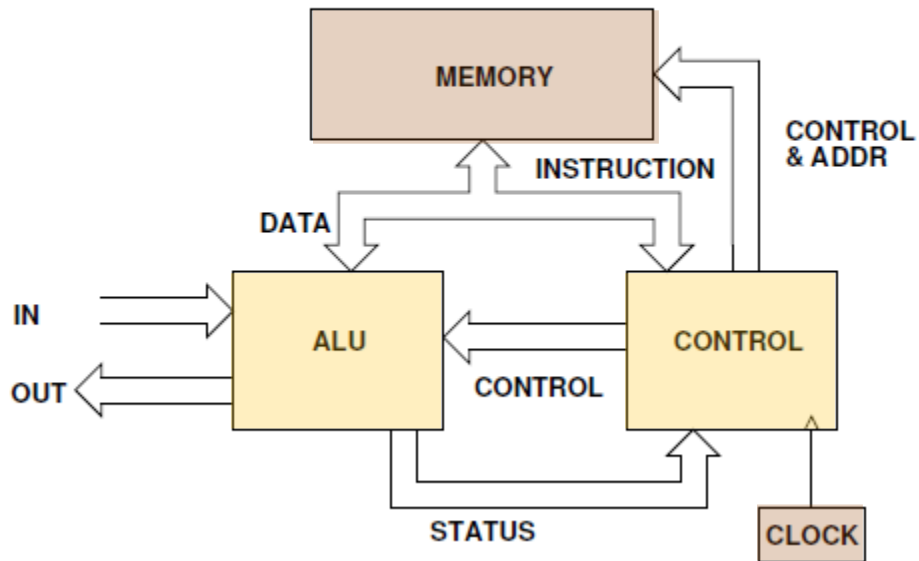


| <b>INSTRUCTION</b> | <b>ACTION</b>                       |
|--------------------|-------------------------------------|
| 18 06              | $(A) + (B) \Rightarrow A$           |
| 87                 | $0 \Rightarrow A$                   |
| 5A 05              | $(A) \Rightarrow \text{Address } 5$ |

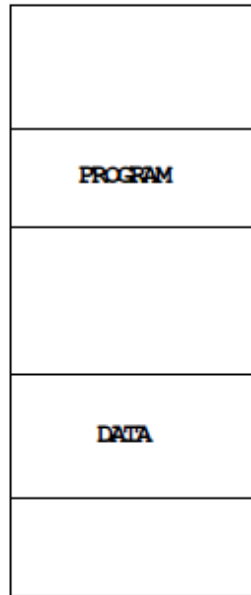
**HARVARD ARCHITECTURE  
MICROPROCESSOR**



**PRINCETON (VON NEUMAN) ARCHITECTURE  
MICROPROCESSOR**



**MEMORY MAP**  
(Princeton Architecture)



Function of memory determined by programmer

|                 |    |   |   |   |   |   |
|-----------------|----|---|---|---|---|---|
| 7               | A  | 0 | 7 | B | 0 | 8-BIT ACCUMULATORS A AND B<br>OR<br>16-BIT DOUBLE ACCUMULATOR D |
| 15              | D  |   |   |   | 0 |   |
| 15              | IX |   |   |   | 0 | INDEX REGISTER X  |
| 15              | IY |   |   |   | 0 | INDEX REGISTER Y  |
| 15              | SP |   |   |   | 0 | STACK POINTER   |
| 15              | PC |   |   |   | 0 | PROGRAM COUNTER   |
| S X H I N Z V C |    |   |   |   |   | CONDITION CODE REGISTER   |

**Figure 2-1. Programming Model**

| <b>Binary</b> | <b>Hex</b> | <b>Decimal</b> |
|---------------|------------|----------------|
| 0000          | 0          | 0              |
| 0001          | 1          | 1              |
| 0010          | 2          | 2              |
| 0011          | 3          | 3              |
| 0100          | 4          | 4              |
| ...           | ...        | ...            |
| 1010          | A          | 10             |
| 1011          | B          | 11             |
| 1100          | C          | 12             |
| 1101          | D          | 13             |
| 1110          | E          | 14             |
| 1111          | F          | 15             |

### **Convert Binary to Decimal**

$1111011_2$

$$1 \times 2^6 + 1 \times 2^5 + 1 \times 2^4 + 1 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 1 \times 2^0$$

$$1 \times 64 + 1 \times 32 + 1 \times 16 + 1 \times 8 + 0 \times 4 + 1 \times 2 + 1 \times 1$$

$123_{10}$

## **Convert Hex to Decimal**

$82D6_{16}$

$$8 \times 16^3 + 2 \times 16^2 + 13 \times 16^1 + 6 \times 16^0$$

$$8 \times 4096 + 2 \times 256 + 13 \times 16 + 6 \times 1$$

$33494_{10}$