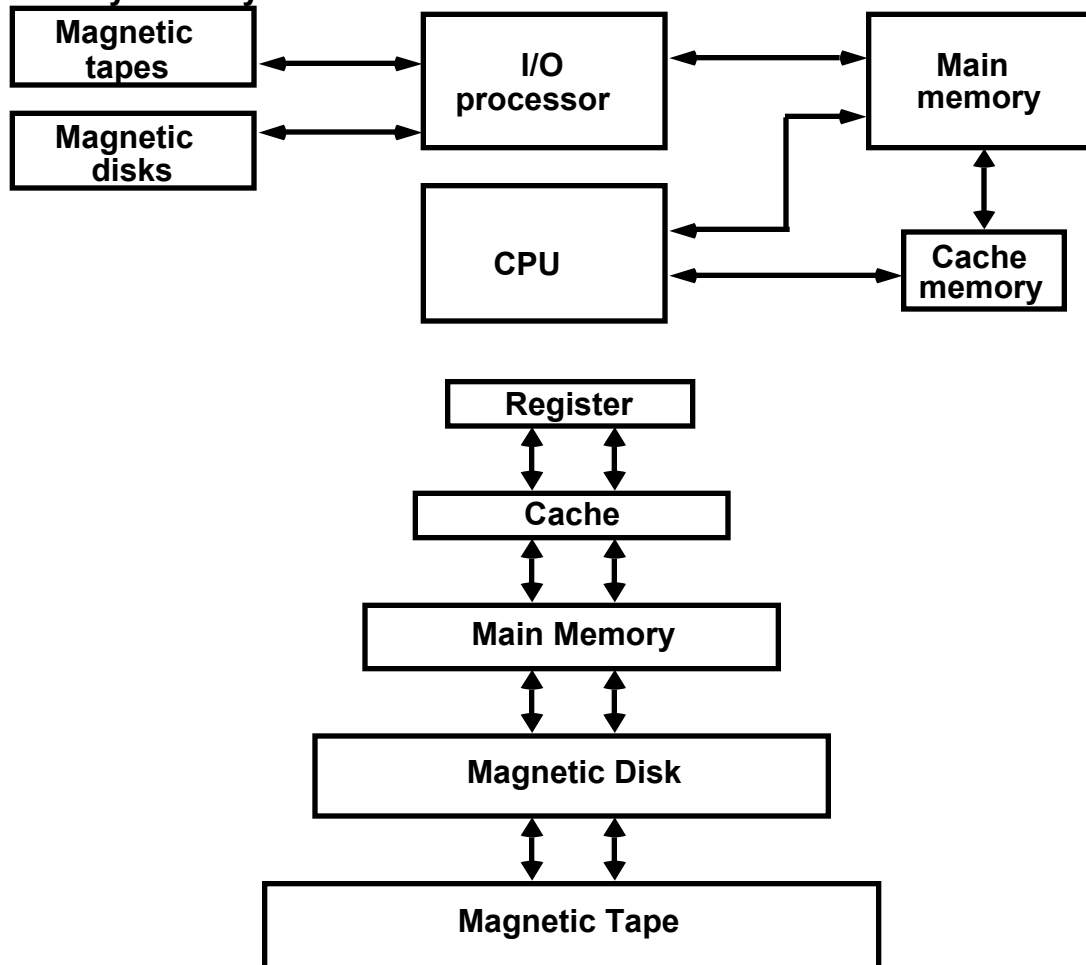# MEMORY  ORGANIZATION

- **Memory Hierarchy**

- **Main Memory**

- **Auxiliary Memory**

- **Associative Memory**

- **Cache Memory**

- **Virtual Memory**

- **Memory Management Hardware**

# MEMORY  HIERARCHY

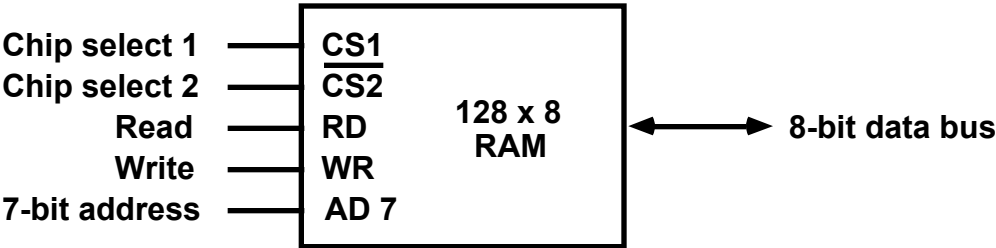**Memory Hierarchy is to obtain the highest possible access speed while minimizing the total cost of the memory system**
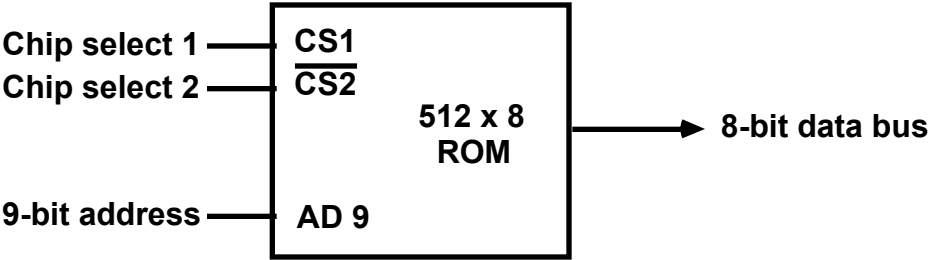
**Auxiliary memory**

| Magnetic tapes | ⟷ | I/O processor | ⟷ | Main memory |

| Magnetic disks | ⟷ | | |

| | | CPU | | Cache memory |

Register

⟷

Cache

⟷

Main Memory

⟷

Magnetic Disk

⟷

Magnetic Tape

# MAIN  MEMORY

## RAM and ROM Chips

### Typical RAM chip

| | | | | | |
|---|---|---|---|---|---|
| Chip select 1 ——— | $\overline{CS1}$ | | | | |
| Chip select 2 ——— | $\overline{CS2}$ | | 128 x 8 | | |
| Read ——— | RD | | RAM | ⟷ | 8-bit data bus |
| Write ——— | WR | | | | |
| 7-bit address ——— | AD 7 | | | | |

| CS1 | $\overline{CS2}$ | RD | WR | Memory function | State of data bus |
|-----|------------------|----|----|-----------------|-------------------|
| 0 | 0 | x | x | Inhibit | High-impedence |
| 0 | 1 | x | x | Inhibit | High-impedence |
| 1 | 0 | 0 | 0 | Inhibit | High-impedence |
| 1 | 0 | 0 | 1 | Write | Input data to RAM |
| 1 | 0 | 1 | x | Read | Output data from RAM |
| 1 | 1 | x | x | Inhibit | High-impedence |

### Typical ROM chip

| | | | | |
|---|---|---|---|---|
| Chip select 1 ——— | $\overline{CS1}$ | | | |
| Chip select 2 ——— | $\overline{CS2}$ | | | |
| | | 512 x 8 | → | 8-bit data bus |
| | | ROM | | |
| 9-bit address ——— | AD 9 | | | |

# MEMORY ADDRESS MAP

**Address space assignment to each memory chip**

**Example:  512 bytes RAM and 512 bytes ROM**

| Component | Hexa address | Address bus | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| RAM 1 | 0000 - 007F | 0 | 0 | 0 | x | x | x | x | x | x | x |
| RAM 2 | 0080 - 00FF | 0 | 0 | 1 | x | x | x | x | x | x | x |
| RAM 3 | 0100 - 017F | 0 | 1 | 0 | x | x | x | x | x | x | x |
| RAM 4 | 0180 - 01FF | 0 | 1 | 1 | x | x | x | x | x | x | x |
| ROM | 0200 - 03FF | 1 | x | x | x | x | x | x | x | x | x |

**Memory Connection to CPU**

     **- RAM and ROM chips are connected to a CPU
through the data and address buses**

     **- The low-order lines in the address bus select
the byte within the chips and other lines in the
address bus select a particular chip through
its chip select inputs**

# CONNECTION OF MEMORY TO CPU
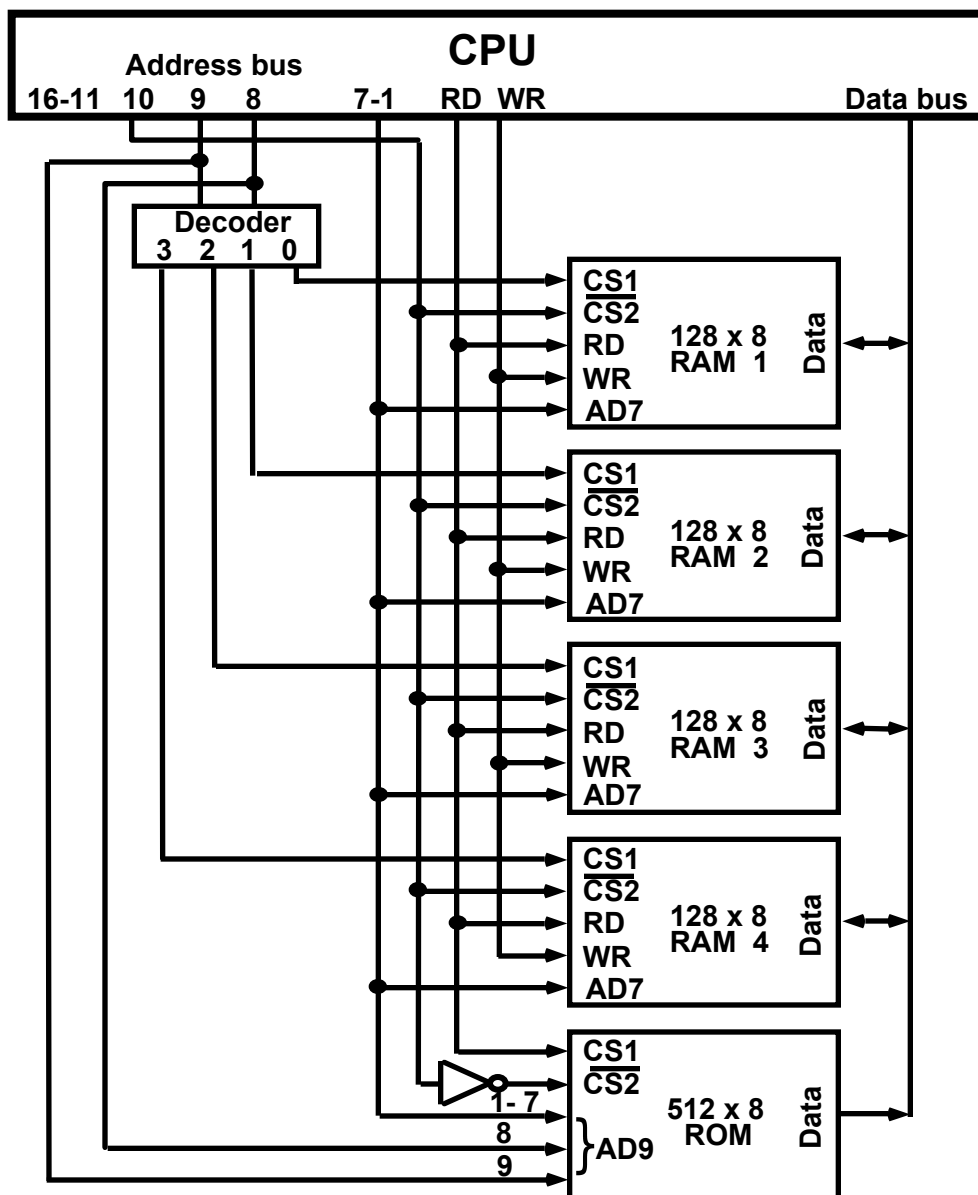
# Auxiliary Memory

- Most common auxiliary memory devices used in computer systems are magnetic disks and tapes.

- not used as frequently, are magnetic drums, magnetic bubble memory, and optical disks.

- important characteristics of any device are its access mode, access time, transfer rate, capacity, and cost.

- **What do you mean by access time?**

- **Seek time ? Transfer rate?**

# Magnetic disk

Tracks

Sector

Read/write head
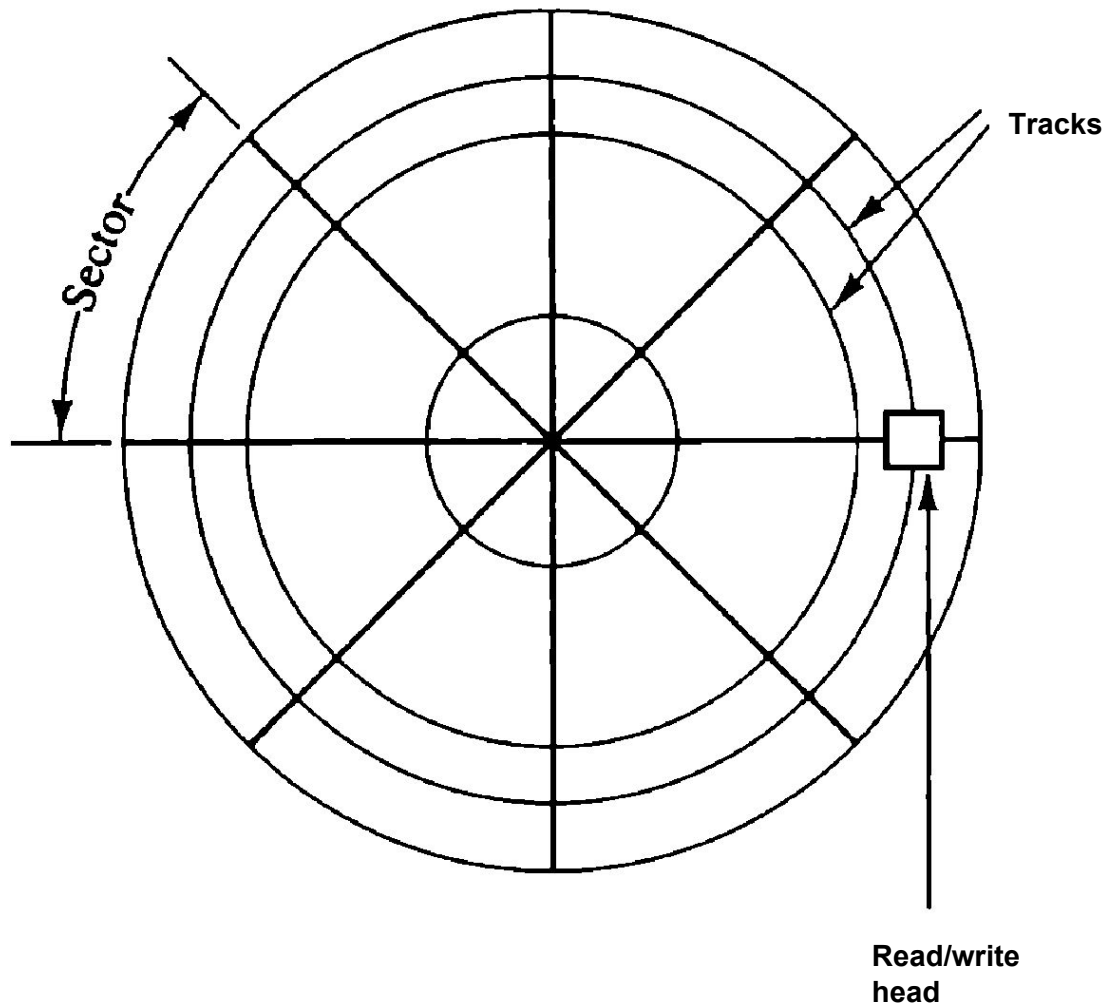
- A magnetic disk is a circular plate constructed of metal or plastic coated with magnetized material.

- Bits are stored in the magnetized surface in spots along concentric circles called tracks.

- The tracks are commonly divided into sections called sectors.

- A disk system is addressed by address bits that specify the disk number, the disk surface, the sector number and the track within the sector.

- Disks that are permanently attached to the unit assembly and cannot be removed by the occasional user are called hard disks .

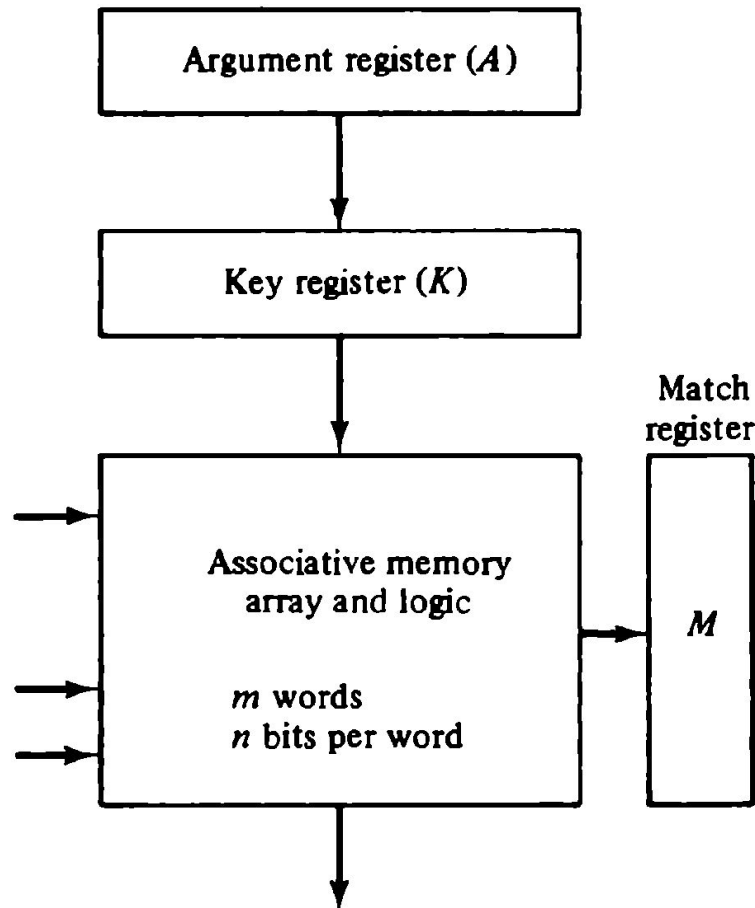- A disk drive with removable disks is called a floppy disk.

# Magnetic Tap

- A magnetic tape transport consists of the electrical, mechanical, and electronic components.

- tape is a strip of plastic coated with a magnetic recording medium.

- Bits are recorded as magnetic spots on the tape along several tracks.seven or nine bits are recorded simultaneously to form a character together with a parity bit.

# Associative Memory

- **Data processing applications-searching a item-searching algorithms-search by specifying address or location.**

- A memory unit accessed by content is called an associative memory or content addressable memory (CAM).

- Memory is accessed simultaneously and in parallel on the basis of data content rather than by specific address or location.

- When a word is written in an associative memory, no address is given.

- The memory is capable of finding an empty unused location to store the word.

- When a word is to be read from an associative memory, the content of the word, or part of the word, is specified.

- The memory locates all words which match the specified content and marks them for reading.

- More expensive than RAM.Why?

- Where used??

# Hardware organization of Associative Memory



Argument register (*A*)

Key register (*K*)

Match register

Associative memory array and logic

*m* words
*n* bits per word

*M*

- suppose that the argument register A and the key register K have the bit configuration shown below. Only the three leftmost bits of A are compared with memory words because K has 1's in these positions.

- A       110 100011

- K        111 000000

- Word 1  110 010110   Match

- Word 2  101 011101   No Match