a) How does file organization differ in the context of solid-state drives (SSDs) compared to traditional hard disk drives (HDDs)?
b) Explain the concept of file access methods (sequential, random, indexed) and their relevance in different file organization systems.

a) **File Organization in SSDs vs HDDs:**

SSDs and HDDs differ in file organization due to their underlying technologies. HDDs rely on spinning disks and mechanical arms, meaning data location affects access times, and fragmentation reduces efficiency. In contrast, SSDs use flash memory with no moving parts, so data can be accessed directly without the impact of fragmentation. However, SSDs must manage wear leveling to prevent excessive wear on specific memory cells.

| **features** | **Solid State Drive (SSD)** | **Hard Disk Drive (HDD)** |
|---|---|---|
| **Speed** | Faster read/write speeds | Slower read/write speeds |
| **Technology** | Use flash memory with no moving parts | Rely on spinning disks and mechanical arms |
| **Accessing Data time** | Directly access to data takes less time | Data location affects access times |
| **Cost** | Expensive | Cheap |

b) **File Access Methods:**

- **Sequential Access**: Records are accessed in order. Search for a record matching a given key. Time is $O(n)$ for n records.
- **Random Access (Direct access)**: Allows direct access to any data location, achieved by calculating the record position using RRN. Time is $O(1)$ for n records
- **Indexed Access**: Uses an index containing a set of keys and their corresponding record addresses. to locate data without sequential searching, like databases. Faster than Sequential Access.

**Question No. 1**

a) Compare between *main* memory and *secondary* storage.

b) What are the main characteristics of good file structure design?

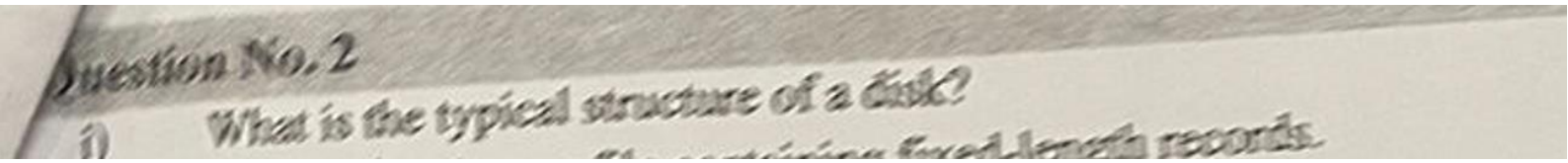
a) **Comparison between Main Memory and Secondary Storage:**

- **Main Memory (RAM)**: Volatile, meaning data is lost when power is off. It is much faster and used for temporary storage of active programs and data currently in use by the CPU. Capacity is smaller compared to secondary storage.
- **Secondary Storage (e.g., HDDs, SSDs)**: Non-volatile, meaning data is retained even without power. It is slower but has much larger storage capacity and is used for long-term data storage. This includes files, applications, and operating systems.

| **Main Memory (RAM)** | **Secondary Storage (ex. HDD, SSD)** |
|---|---|
| Volatile | Non-Volaitle |
| Faster | Slower |
| Used for temporary storage of active programs. | Used for long-term data storage ex (files, applications) |
| Smaller storage capacity | Larger Storage capacity |

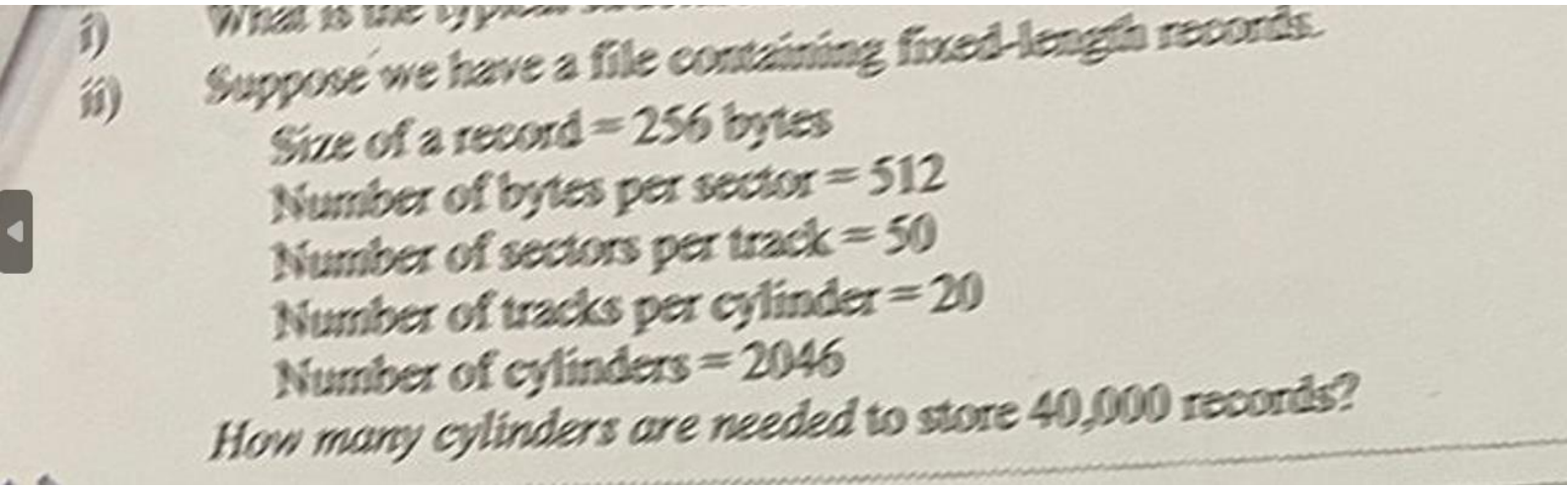
b) **Main Characteristics of Good File Structure Design:**

- Fast access to great capacity.
- Reduce disk journey (number of disk access).
- Group data into blocks and buffers.
- Handel growth by splitting big data.




**Typical structure of a disk**:

- **Platters**: the disk contains one or more platters.
- **Tracks**: each platter is divided into tracks.
- **Sectors**: each track is divided into sectors.
- **Clusters**: sectors are grouped into clusters.
- **Cylinders**: set of tracks aligned vertically across platters.
- **Disk Heads**: magnetic heads that read/write data on platters.
- **Spindle**: manage the movement of the platters.
- **Seek Time**: time taken by disk head.
- **Rotational Delay**: time for sector to reach head.




**Step-by-Step Process:**

1. **Calculate how many records fit in one sector:**

$$\text{Number of records per sector} = \frac{\text{Bytes per sector}}{\text{Size of a record}} = \frac{512}{256} = 2 \text{ records per sector}$$

2. **Calculate how many records fit in one track:**

$$\text{Records per track} = \text{Number of records per sector} \times \text{Number of sectors per track} = 2 \times 50 = 100 \text{ records per track}$$

3. **Calculate how many records fit in one cylinder:**

$$\text{Records per cylinder} = \text{Records per track} \times \text{Tracks per cylinder} = 100 \times 20 = 2000 \text{ records per cylinder}$$

4. **Determine how many cylinders are needed:**

$$\text{Number of cylinders} = \frac{\text{Total records}}{\text{Records per cylinder}} = \frac{40000}{2000} = 20 \text{ cylinders}$$

So, **20 cylinders** are required to store 40,000 records.

a) Describe the differences between physical and logical file address and their importance in data retrieval. 5 points

b) What is the primary purpose of a file organization system in computer science?

**Differences Between Physical and Logical File Addresses in Data Retrieval:**

- **Physical file address** refers to the exact location of data on the storage medium.
- **Logical file address** refers to the location on the operating system such as a file path.

**Importance in Data Retrieval**: Logical addresses allow users to interact with files without needing to know their physical locations.

**b) Primary Purpose of a File Organization System in Computer Science:**

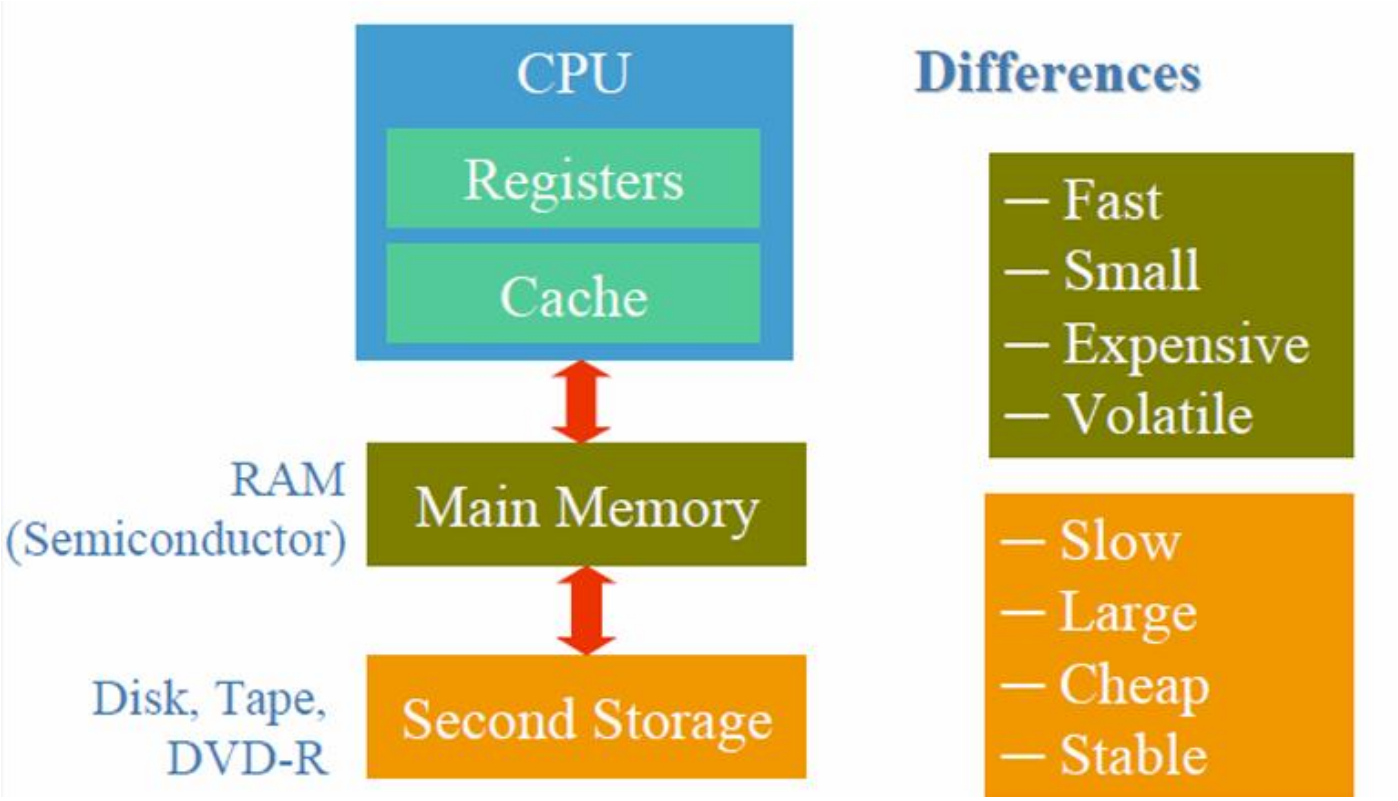
- Manage data on storage media and supports different file access methods such as sequential, random, or indexed access.

What is the file structure and what are the main roles of file structure?

- File structure combination of representation for data and access operations.
- Main roles are to allow applications to:
  - Read, write, modify, and access data.
  - Finding data that matches search

**File Header:** Metadata at the start of a file, providing essential file info.

**Memory Hierarchy:** Arranges storage types by speed and cost: registers, cache, RAM, secondary storage.




**Good File Structure Design:** It should be efficient, organized, accessible, secure, and scalable.