Tutorial 3: I/O and Memory Structure

1. Distinguish between synchronous and asynchronous I/O.

- **Synchronous I/O:** The CPU waits until the I/O operation completes (no overlap).
- **Asynchronous I/O:** The CPU continues executing other tasks while the I/O operation is in progress.

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2. What is the function of the device-status table?

It stores information about each I/O device (type, address, and state).
The OS uses it to manage multiple devices and check their current status.

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3. Explain the purpose of Direct Memory Access (DMA).

DMA allows high-speed devices to transfer blocks of data directly between memory and the device **without CPU intervention**, improving performance and reducing CPU workload.

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4. Describe what happens when the CPU uses DMA for disk operations.

- The disk controller transfers data directly from disk buffer to main memory.
- The CPU is interrupted only once per block transfer, not per byte.
- This allows CPU and I/O to work in parallel.

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5. Differentiate between ROM and RAM.

Aspect	RAM	ROM
Volatility	Volatile	Non-volatile
Function	Temporary storage for active processes	Permanent storage for firmware
Write capability	Read/write	Read-only

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6. Define caching and explain its purpose.

Caching is temporarily storing frequently used data in faster storage to reduce access time.
It improves performance by avoiding repeated access to slower storage.

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7. Give examples of caching at different levels.

- **Hardware:** CPU cache (L1, L2, L3)
- **Operating System:** Disk cache or page cache
- **Software/Application:** Web cache or database cache

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8. What are the design challenges in caching?

- Cache size limitations
- Replacement policies (deciding which data to remove)
- Consistency between cache and main memory

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9. Describe the memory hierarchy from fastest to slowest.

Registers → Cache → Main Memory → Secondary Storage → Tertiary Storage
(Speed decreases, size and cost per bit decrease down the hierarchy.)