

Answer 1a] An operating system (OS) is a critical component of computer systems that serves as an intermediary between users and the computer hardware. It manages hardware resources such as the CPU, memory, disk space, and I/O devices while providing a user-friendly environment for users to interact with the system. The OS handles various tasks, including process scheduling, memory management, file management, and device control. Common examples of operating systems include Windows, macOS, Linux, and Android.

The main functions of an operating system can be classified as follows:**Process Management:** The OS manages the execution of processes, which are instances of programs in execution. It is responsible for process scheduling, creation, termination, and synchronization. The OS ensures that multiple processes can run simultaneously without interference.**Memory Management:** This function involves managing the computer's memory, including RAM and cache. The OS allocates memory to processes, tracks memory usage, and ensures that processes do not interfere with each other's memory. Virtual memory techniques may be employed to extend physical memory using disk space.**File System Management:** The OS provides a structured way to store and retrieve data on storage devices through a file system. It manages file creation, deletion, reading, writing, and organization in directories. It ensures data integrity and provides security mechanisms for file access.

Answer 2a] A **process** is an independent program in execution, encapsulating its own memory space, code, data, and resources. Each process has its own address space and does not share memory with other processes, which provides isolation and stability. A process can consist of one or more threads.

A **thread**, on the other hand, is the smallest unit of execution within a process. Threads within the same process share the same memory and resources, allowing for efficient communication and coordination. However, this also means that if one thread encounters an error or crashes, it can affect the entire process.

Answer 3a] The kernel is the core component of an operating system that interacts directly with the hardware. It serves as a bridge between the applications and the physical hardware of the computer. The kernel performs essential functions, including:

Resource Management: The kernel allocates and manages resources such as CPU time, memory, and I/O devices, ensuring fair and efficient usage among processes.**Process Scheduling:** The kernel schedules processes for execution, deciding which process runs at any given time based on scheduling algorithms. It manages context switching to allow multitasking.**System Calls:** The kernel provides an interface for applications to request services such as file access, memory allocation, and process control through system calls.**Interrupt Handling:** The kernel responds to hardware interrupts, allowing the OS to manage asynchronous events like I/O requests and timer signals.

Answer 4a] Virtual memory is a memory management technique that enables a computer to compensate for physical memory shortages by temporarily transferring data from random access memory (RAM) to disk storage. It creates the illusion of a large memory space for applications, allowing them to use more memory than is physically available. Virtual memory provides several key benefits:

Increased Memory Capacity: It allows systems to run larger applications or multiple applications simultaneously, even if the total memory demand exceeds physical RAM.

Isolation: Each process operates in its own virtual address space, providing protection and isolation from other processes. This enhances security and stability, as a crash in one process does not affect others.

Answer 5a] A file system is a method and structure used by the operating system to manage and organize files on storage devices. It provides a hierarchical structure for storing data and facilitates file operations such as creation, deletion, reading, and writing. Key functions of a file system include:

Data Organization: The file system organizes files into directories or folders, allowing users to navigate and manage their data easily. Each file and directory is assigned a unique name and attributes (e.g., permissions, timestamps). **Access Control:** The file system enforces security measures by managing user permissions for file access. It restricts or grants read, write, and execute permissions to users and groups. **Data Integrity:** The file system ensures data integrity through techniques like journaling, which logs changes before they are committed, protecting against data corruption in case of failures. **File Metadata Management:** The file system maintains metadata about files, including their size, location, creation date, and modification date, enabling efficient file access and management.

Answer 6a] A deadlock is a state in a multiprogramming environment where two or more processes are unable to proceed because each is waiting for the other to release resources. This situation results in a standstill, with no process able to make progress. Deadlocks typically arise from the following conditions, known as the Coffman conditions:

Mutual Exclusion: At least one resource must be held in a non-shareable mode; only one process can use the resource at a time. **Hold and Wait:** Processes holding resources are allowed to request additional resources. **No Preemption:** Resources cannot be forcibly taken from a process holding them; they must be voluntarily released.