Advanced Operating System Question Bank

Lecture Questions

▼ Q.1 What is a Deadlock? Necessary conditions for deadlock?

Deadlock is a situation where a process already using a resource is waiting to acquire the resources held by other processes. Thus each process waits for an indefinite amount of time for an event that may or may not occur.

Necessary conditions for a deadlock to occur:

1. **Mutual exclusion**: Only one process at a time can use a resource.
2. **Hold & Wait**: A process holding at least one resource is waiting to acquire additional resources held by other processes.
3. **No preemption**: A resource can be released only voluntarily by the process holding it, after that process has completed its task.
4. **Circular wait**: There exists a set $\{P_0, P_1, ..., P_n\}$ of waiting processes such that P_0 is waiting for a resource that is held by P_1, P_1 is waiting for a resource that is held by $P_2, ..., P_{n-1}$ is waiting for a resource that is held by P_n & P_n is waiting for a resource that is held by P_0.

▼ Q.2 What is demand paging? data structures of demand paging? Example with diagram.

Demand paging is a method of Virtual memory Management.

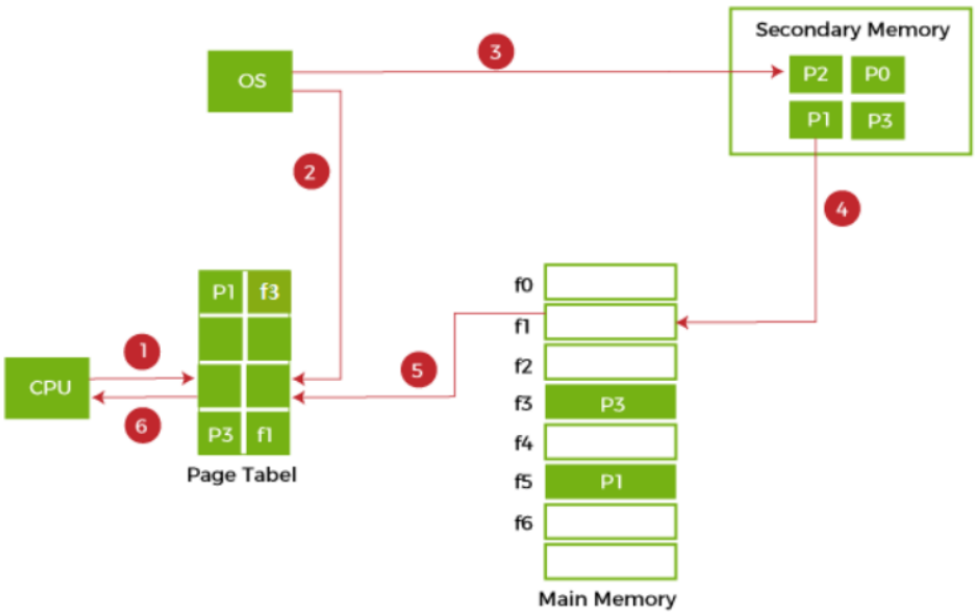
Demand paging is a process in which data is moved from secondary memory to RAM on a demand basis, which means all data is not stored in the main memory because the space is limited in RAM.

So if the CPU demands the process, if that page is not in RAM, then swapping is needed.

This means shifting the existing page from RAM and putting it back in secondary memory and putting the new page in RAM.

Demand paging is an essential feature of modern operating systems, and it helps ensure that all processes have access to the memory they need.

- E.g. - Suppose we have to execute a process P having four pages P_0, P_1, P_2 and P_3. Currently, in the page table, we have pages P_1 and P_3.



1. If the CPU wants to access page P_2 of a process P, it will first search the page in the page table.
2. As the page P2 is not found in the page table so it will be a page fault.
3. The control goes to the OS and context switching takes place, and the OS puts the process in a waiting state.
4. OS loads page P2 from secondary memory to main memory and will update the page table.
5. The control is taken back from the OS, and the execution of the process is resumed.

Data Structures in Demand paging:

1. Page table entries.
2. Disk block descriptors.
3. Page frame data table (pfdata).
4. Swap-use table.

Advantages:

1. Only loads pages that are demanded by the executing process.

2. As there is more space in main memory, more processes can be loaded.

Disadvantages:

1. More complex.
2. Less power.

▼ Q.3 Locality of reference?

Locality of reference refers to the tendency of the computer program to access the same set of memory locations for a particular time period.

The property of Locality of Reference is mainly shown by loops and subroutine calls in a program.

On an abstract level there are two types of localities which are as follows:

1. **Temporal locality**: Temporal locality refers to the reuse of specific data and/or resources within a relatively small time duration.
2. **Spatial locality**: Spatial locality (also termed data locality) refers to the use of data elements within relatively close storage locations.

▼ Q.4 Page Stealer Process?

This is the Kernel process that makes room for the incoming pages, by swapping the memory pages that are not the part of the working set of a process.

Page-Stealer is created by the Kernel at the system initialization and invokes it throughout the lifetime of the system.

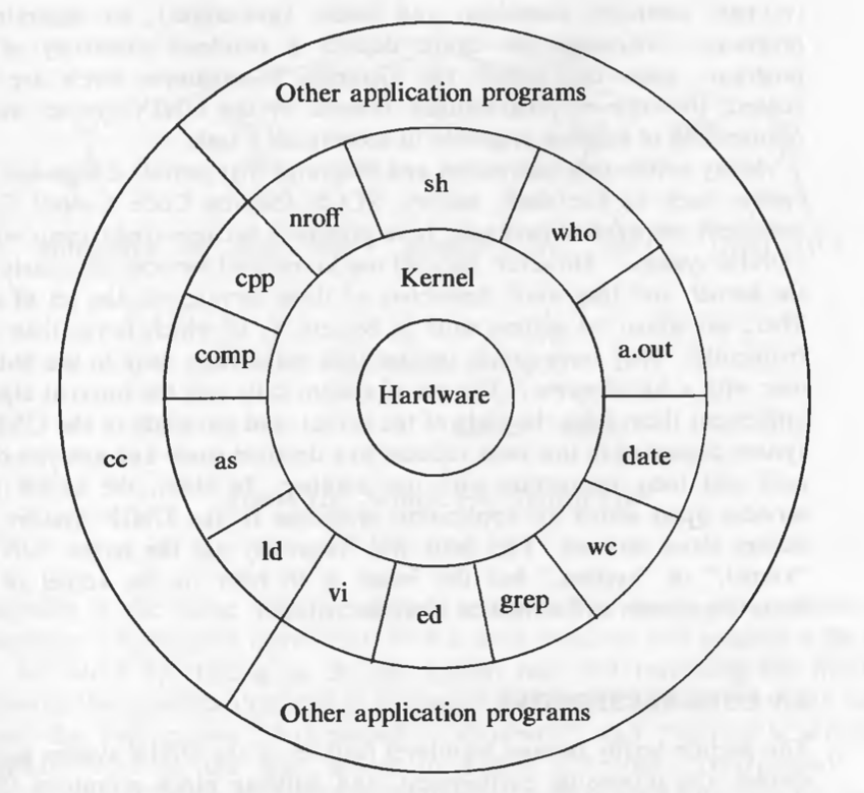
▼ Q.5 Page Fault? Two types of page fault.

A page fault occurs when a program attempts to access data or code that is in its address space, but is not currently located in the system RAM.

Types of page fault:

1. **Minor Page Fault**: A small page fault or soft page fault happens when a page is loaded into memory when a fault occurs.
2. **Major Page Fault**: A major page fault is an exception that occurs when a process attempts to access memory in a way that exceeds its permissions.
3. **Invalid Page Fault**: An invalid page fault happens when a page fault references an address that does not belong to the virtual address space.

▼ Q.6 What is an OS? Why do we need it?



The Unix operating system is a set of programs that act as a link between the computer and the user. It is a stable, multi-user, multi-tasking system for servers, desktops and laptops .

UNIX is made up of 4 main parts:

1. The Kernel:
    a. The kernel is the heart of the operating system.
    b. It interacts with the hardware to perform various tasks like memory allocation and file storage.
2. The Shell:
    a. The shell is the utility that processes your requests.
    b. When you type in a command at your terminal, the shell interprets the command and calls the program that you want.
3. Commands and Utilities:
    a. There are various commands and utilities which you can make use of.
    b. cp, mv, cat and grep, etc. are few examples of commands and utilities.
4. Files and Directories:

a. All the data of Unix is organized into files.

b. All files are then organized into directories.

c. These directories are further organized into a tree-like structure called the filesystem.

▼ Q.7 What are data region, stack region, and address space?

Data Region: In computing, a data segment (often denoted . data) is a portion of an object file or the corresponding address space of a program that contains initialized static variables, that is, global variables and static local variables.

Stack Region: A stack is a special area of a computer's memory which stores temporary variables created by a function. In stack, variables are declared, stored and initialized during runtime. It is a temporary storage memory.

Address Space: The range of virtual addresses that the operating system assigns to a user or separately running program is called an address space. This is the area of contiguous virtual addresses available for executing instructions and storing data.

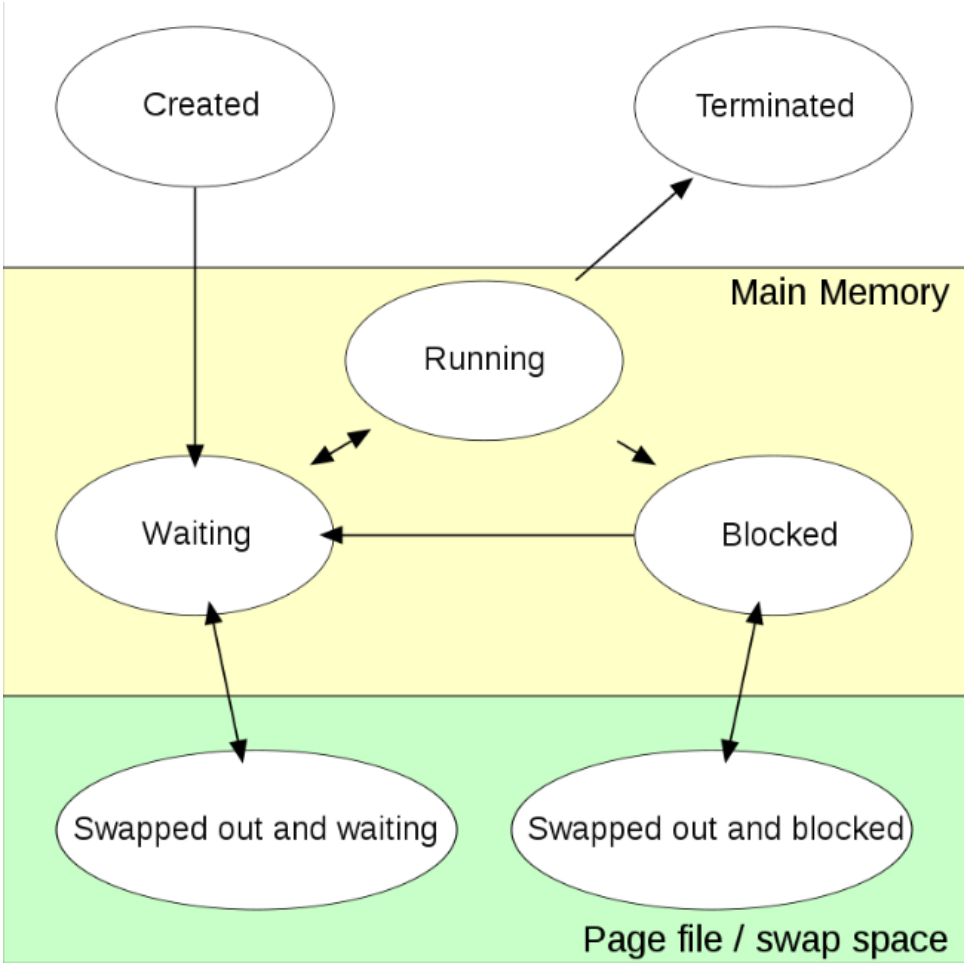
▼ Q.8 What is address space?

Same as Q.7

▼ Q.9 What is the difference between program and process?

Program	Process
A program is a collection of instructions that are used to complete a specific task.	A process is a program in execution
A program is a passive entity	A process is an active entity
It is considered as a static entity.	It is considered as a passive entity.
It doesn't have a control block	It have its own control block called, Process Control Block

▼ Q.10 Process state transition diagram?



Created: A program which is going to be picked up by the OS into the main memory is called a new process.

Ready: Whenever a process is created, it directly enters in the ready state, in which it waits for the CPU to be assigned.

Running: One of the processes from the ready state will be chosen by the OS depending upon the scheduling algorithm

Block/Wait: A process already using a resource waits to acquire other resources held by another process

Swapped out and waiting: In systems that support virtual memory, a process may be swapped out, that is, removed from main memory and placed on external storage by the scheduler. From here the process may be swapped back into the waiting state.

Swapped out and blocked: Processes that are blocked may also be swapped out. In this event the process is both swapped out and blocked, and may be swapped back in again.

▼ Q.11 What is scheduling?

Multiprogramming operating systems rely heavily on process scheduling. It is the process of removing an active task from the processor and replacing it with a new one. It divides a procedure into states such as ready, waiting, or running.

Process scheduling is an essential part of a Multiprogramming operating systems. Such operating systems allow more than one process to be loaded into the executable memory at a time and the loaded process shares the CPU using time multiplexing.

There are two categories of scheduling:

1. **Non-preemptive:** Here the resource can't be taken from a process until the process completes execution. The switching of resources occurs when the running process terminates and moves to a waiting state.
2. **Preemptive:** Here the OS allocates the resources to a process for a fixed amount of time. During resource allocation, the process switches from running state to ready state or from waiting state to ready state. This switching occurs as the CPU may give priority to other processes and replace the process with higher priority with the running process.

▼ Q.12 What is the purpose of a fork with syntax?

The only way to create a new process in UNIX is to use the fork system call. The process
which calls fork is called the parent process and the newly created process is called the
child process. Also, the process 0 is the only process which is not created via fork.

The child process is exactly the same as its parent but there is difference in the processes ID's:

1. The process ID of the child process is a unique process ID which is different from the ID's of all other existing processes.
2. The Parent process ID will be the same as that of the process ID of child's parent.

Syntax: $pid = fork();$

▼ Q.13 What is page fault?

It mainly occurs when any program tries to access the data or the code that is in the address space of the program, but that data is not currently located in the RAM of the system.

- So basically when the page referenced by the CPU is not found in the main memory then the situation is termed as Page Fault.
- Whenever any page fault occurs, then the required page has to be fetched from the secondary memory into the main memory.

The page fault mainly generates an exception, which is used to notify the operating system that it must have to retrieve the "pages" from the virtual memory in order to continue the execution. Once all the data is moved into the physical memory the program continues its execution normally.

▼ Q.14 What is virtual memory?

Virtual Memory is a storage mechanism which offers user an illusion of having a very big main memory. It is done by treating a part of secondary memory as the main memory. In Virtual memory, the user can store processes with a bigger size than the available main memory.

Therefore, instead of loading one long process in the main memory, the OS loads the various parts of more than one process in the main memory. Demand Paging is a popular method of virtual memory management. In demand paging, the pages of a process which are least used, get stored in the secondary memory.

▼ Q.15 What is the file system of UNIX?

The Unix file system is a methodology for logically organizing and storing large quantities of data such that the system is easy to manage. A **file** can be informally defined as a collection of data, which can be logically viewed as a stream of bytes (i.e. characters). A file is the smallest unit of storage in the Unix file system.

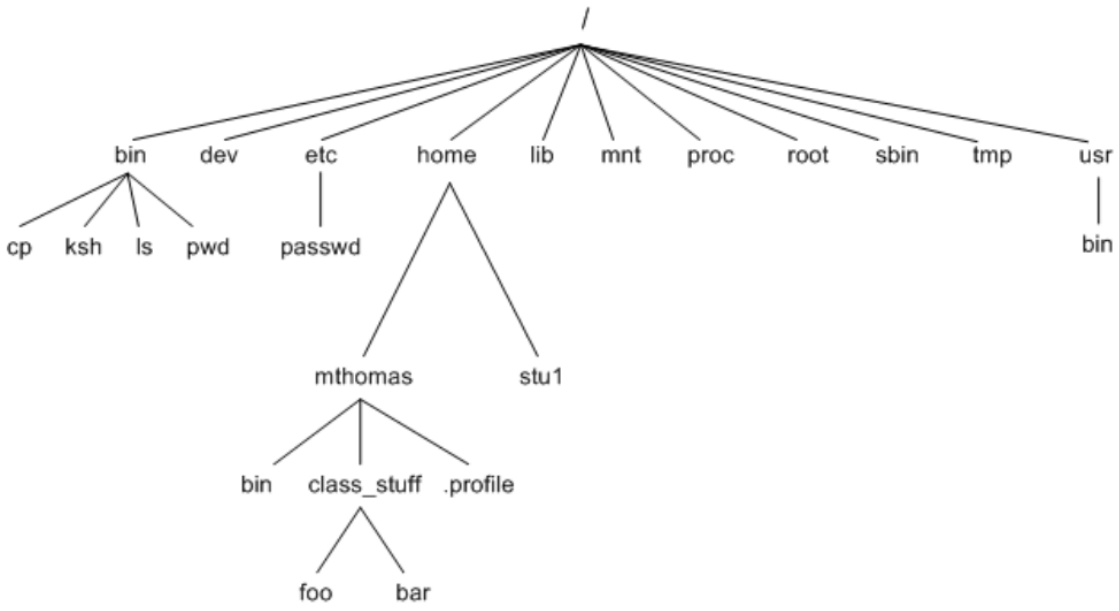
A **file system** consists of files, relationships to other files, as well as the attributes of each file. File attributes are information relating to the file, but do not include the data contained within a file. File attributes for a generic operating system might include:

- a file type
- a file name
- a physical file size

- a file owner
- file protection
- file time stamp

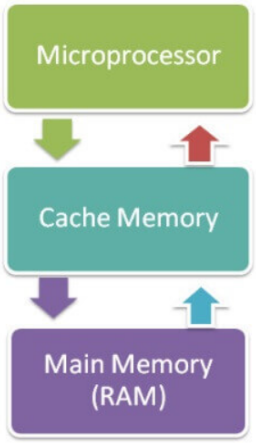
File systems provide tools which allow the manipulation of files, provide a logical organization as well as provide services which map the logical organization of files to physical devices. the Unix file system is essentially composed of files and **directories**. Directories are special files that may contain other files.

The Unix file system has a hierarchical (or tree-like) structure with its highest level directory called root (denoted by /). Immediately below the root level directory are several subdirectories, most of which contain system files. Below this can exist system files, application files, and/or user data files. Similar to the concept of the process parent-child relationship, all files on a Unix system are related to one another. That is, files also have a parent-child existence. Thus, all files (except one) share a common parental link, the top-most file (i.e. /) being the exception.



▼ Q.16 Why do we need cache data structure?

Cache memory is a high-speed memory, which is small in size but faster than the main memory (RAM). The CPU can access it more quickly than the primary memory. So, it is used to synchronize with high-speed CPU and to improve its performance.



Cache memory can only be accessed by CPU. It can be a reserved part of the main memory or a storage device outside the CPU. It holds the data and programs which are frequently used by the CPU. So, it makes sure that the data is instantly available for CPU whenever the CPU needs this data. In other words, if the CPU finds the required data or instructions in the cache memory, it doesn't need to access the primary memory (RAM). Thus, by acting as a buffer between RAM and CPU, it speeds up the system performance.

▼ Q.17 What are interrupts and exceptions?

Exceptions and interrupts are unexpected events which will disrupt the normal flow of execution of instruction.

Exceptions occur during program execution and are so extraordinary that they cannot be handled by the program itself. If you give the processor the command to divide a number by zero, for instance, it will give a divide-by-zero exception, which will cause the computer to either stop the operation or display an error notice.

Interruptions are sudden occurrences that bring to a halt the consistent flow of instructions being carried out by a system. It instructs the operating system to take immediate action on the following steps to take. These unforeseen occurrences are typically associated with an I/O device, which is primarily concerned with communicating with the outside world.

Whenever an exception or interrupt occurs, the hardware starts executing the code that performs an action in response to the exception. The instructions responsible for this action reside in the operating system kernel, and the code that performs this action is called the interrupt handler code.

▼ Q.18 Context of a process.

Each time a process is removed from access to the processor, sufficient information on its current operating state must be stored such that when it is again scheduled to run on the processor it can resume its operation from an identical position. This operational state data is known as its **context** and the act of removing the process's thread of execution from the processor (and replacing it with another) is known as a *process switch* or *context switch.*

The context of a process includes its address space, stack space, virtual address space, register set image (e.g. Program Counter (PC), Stack Pointer (SP), Instruction Register (IR), Program Status Word (PSW) and other general processor registers).

This state information is saved in the process's process control block which is then moved to the appropriate scheduling queue. The new process is moved to the CPU by copying the PCB info into the appropriate locations.

▼ Q.19 Functioning of an OS.

An Operating System acts as a communication bridge (interface) between the user and computer hardware. The purpose of an operating system is to provide a platform on which a user can execute programs in a convenient and efficient manner.

An operating system is a piece of software that manages the allocation of computer hardware. The coordination of the hardware must be appropriate to ensure the correct working of the computer system and to prevent user programs from interfering with the proper working of the system.

The operating system is commonly called the system kernel, or just the kernel, emphasizing its isolation from user programs.

Important functions of an operating System:

1. Security
2. Control over system performance
3. Job accounting
4. Error detecting aids
5. Coordination between other software and users
6. Memory Management
7. Processor Management
8. Device Management

9. File Management

Operating System Services:

1. Kernel controls creation, termination or suspension, and communication of the
   process.
2. Process scheduling.
3. Allocating main memory for an executing process.
4. Allocating secondary memory for efficient storage an retrieval of user data.
5. Allowing processes controlled access to peripheral devices such as terminals,
   tape drives, disk drives, and network devices.

▼ Q.20 Why is UNIX different from other OS?

There are various main differences between the UNIX and other. Some of them are as follows:

1. UNIX operating system comes with a Command Line Interface (CLI). In contrast, other operating systems come with a Graphical User Interface (GUI).
2. Multiprocessing is possible in the UNIX OS.
3. UNIX is a free and open-source OS. In contrast to other OS.
4. Unix operating system is known for being very stable to execute.
5. Unix is a flexible operating system that may be installed on various systems, including mainframes, supercomputers, and microcomputers.

▼ Q.21 Compare UNIX with other OS?

Parameters	**UNIX**	Other OS
Basic	It is a command-based operating system.	Menu based operating system.
Licensing	It is an open-source system which can be used to under General Public License.	Maybe a proprietary software.
User Interface	It has a text base interface, making it harder to grasp for newcomers.	Has a Graphical User Interface, making it simpler to use.

Parameters	UNIX	Other OS
Processing	It supports Multiprocessing.	It supports Multithreading.
File System	It uses Unix File System(UFS) that comprises STD.ERR and STD.IO file systems.	Uses File Allocation System (FAT32) and New technology file system(NTFS).
Security	It is more secure as all changes to the system require explicit user permission.	Less secure compared to UNIX.
Hardware	Hardware support is limited in UNIX system. Some hardware might not have drivers built for them.	Drivers are available for almost all the hardware.
Reliability	Unix and its distributions are well known for being very stable to run.	Although Windows has been stable in recent years, it is still to match the stability provided by Unix systems.

▼ Q.22 Features of UNIX.

1. **Multiuser System**: Since all the resources are shared among all the users, it is called a Multiuser system. In this, one user can do multiple tasks. For doing this, a small slice of time is given by a computer to a user to divide the unit into several segments. At a particular instant of time, the CPU is addressing only one user but since the switching time of the switch is so quick, it creates an illusion that multiple users are addressed simultaneously. This is also called context switching where the state of the switch is changed from one state to another.
2. **Portability**
3. **Hierarchical File System**
4. **UNIX Toolkit**: UNIX provides various facilities regarding types of tools like awk, UNIX grep, sed, etc. The general-purpose tool used is a network application, compiler, interpreter, etc. Various server programs are also included for providing remote administrative services.
5. **Program Execution**: To execute UNIX programs, the only thing that a user needs to do is type its name, and preceding name, type ./ for checking if the file is executable or not.
6. **Multitask system**: A user might run multiple tasks concurrently, for instance, editing a file, browsing the net, printing the file, etc.

7. **Pattern Matching**: UNIX provides a complex feature for matching patterns in file names. A special character, meta-char ‘’ is used by the system for matching the file name.
8. **Programming Facility**: The UNIX system has a programming language, the shell that is specially designed for programmers instead of normal users. It has features like loops, variables, and control structures required for programming. All these features are designed for shell scripts for invoking commands in UNIX.
9. **Documentation**: It has a command for the manual which is ‘man’, which is used as a reference command and for configuring files. There’s a vast amount of information available on the Internet apart from online documentation or GitHub.
10. **Machine-independence**
11. **Handling I/O operations**

Reference

https://github.com/suvratapte/Maurice-Bach-Notes/