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Course Title:Operating System

CT:2

1.a)What is deadlock and what are the conditions for arising deadlock?   2+2

b)Explain methods for handling deadlock.   4

c) What do you mean by deadlock avoidance ? Write down some example of deadlock.   4+2

2.a)What do you mean by memory management and why we use memory management?   3+3

b)What is swapping?What are the benefits of swapping?   3+3

c)Write down the difference between static and dynamic loading.   2

3.a)What is fragmentation?Types of fragmentation.   3+3

b)What is virtual memory and how it works?   2+2

c)Describe the benefits of having virtual memory.   4

4.a) What are the advantage of virtual memory?   4

b) Briefly explain memory management technique.   6

c) Describe about FIFO page replacement method.   4

5.a)Describe different types of page replacement method. 6

b)What do you mean by demand paging and thrashing? 2+2

c)Why we need virtual memory? 4

6.a)What is file system?Explaim the objective of file management system. 3+3

b)What are the functions of file? 4

c)Describe about commonly used terms in file systems. 4

7.a)Explain file access method. 5

b)What do you mean by space allocation? 5

c)Describe about file directories. 4

8.a)What is file system structure? 6

b)Briefly explain about file system layer. 4

c)write down the advantages of deadlock. 4

Answer to the question number (1)

a)

Deadlock: Deadlock is a situation where a set of processes are blocked because each process is holding a resource and waiting for another resource acquired by some other process. Consider an example when two trains are coming toward each other on the same track and there is only one track, none of the trains can move once they are in front of each other. A similar situation occurs in operating systems when there are two or more processes that hold some resources and wait for resources held by other.

Deadlock can arise if the **following four conditions hold simultaneously (Necessary Conditions):**

Mutual Exclusion: One or more than one resource are non-shareable (Only one process can use at a time)
Hold and Wait:A process is holding at least one resource and waiting for resources.
No Preemption:A resource cannot be taken from a process unless the process releases the resource.
Circular Wait: A set of processes are waiting for each other in circular form.

b)

Methods for handling deadlock:
 There are three ways to handle deadlock:

1) Deadlock prevention or avoidance: The idea is to not let the system into a deadlock state. One can zoom into each category individually,Prevention is done by negating one of above mentioned necessary conditions for deadlock.
Avoidance is kind of futuristic in nature. By using strategy of "Avoidance", we have to make an assumption. We need to ensure that all information about resources which process will need are known to us prior to execution of the process. We use Banker's algorithm (Which is in-turn a gift from Dijkstra) in order to avoid deadlock.
2) Deadlock detection and recovery: Let deadlock occur, then do preemption to handle it once occurred.

3) Ignore the problem altogether: If deadlock is very rare, then let it happen and reboot the system. This is the approach that both Windows and UNIX take.

c)

Deadlock avoidance: In deadlock avoidance, the request for any resource will be granted if the resulting state of the system doesn't cause deadlock in the system. The state of the system will continuously be checked for safe and unsafe states.

In order to avoid deadlocks, the process must tell OS, the maximum number of resources a process can request to complete its execution.

The simplest and most useful approach states that the process should declare the maximum number of resources of each type it may ever need. The Deadlock avoidance algorithm examines the resource allocations so that there can never be a circular wait condition.

- A real-world example would be traffic, which is going only in one direction.
- Here, a bridge is considered a resource.
- So, when Deadlock happens, it can be easily resolved if one car backs up (Preempt resources and rollback).
- Several cars may have to be backed up if a deadlock situation occurs.
- So starvation is possible.

Answer to the question number (2)

a)

Memory management: Memory Management is the process of controlling and coordinating computer memory, assigning portions known as blocks to various running programs to optimize the overall performance of the system.

It is the most important function of an operating system that manages primary memory. It helps processes to move back and forward between the main memory and execution disk. It helps OS to keep track of every memory location, irrespective of whether it is allocated to some process or it remains free.

Why we use memory management:

- It allows you to check how much memory needs to be allocated to processes that decide which processor should get memory at what time.
- Tracks whenever inventory gets freed or unallocated. According to it will update the status.
- It allocates the space to application routines.
- It also make sure that these applications do not interfere with each other.
- Helps protect different processes from each other
- It places the programs in memory so that memory is utilized to its full extent.

b)

Swapping: Swapping is a method in which the process should be swapped temporarily from the main memory to the backing store. It will be later brought back into the memory for continue execution.

Backing store is a hard disk or some other secondary storage device that should be big enough inorder to accommodate copies of all memory images for all users. It is also capable of offering direct access to these memory images.

Benefits of swapping:

- It offers a higher degree of multiprogramming.
- Allows dynamic relocation. For example, if address binding at execution time is being used, then processes can be swap in different locations. Else in case of compile and load time bindings, processes should be moved to the same location.
- It helps to get better utilization of memory.
- Minimum wastage of CPU time on completion so it can easily be applied to a priority-based scheduling method to improve its performance.

c)

Difference between static and dynamic loading are given bellow:

Static Loading	Dynamic Loading
Static loading is used when you want to load your program statically. Then at the time of compilation, the entire program will be linked and compiled	In a Dynamically loaded program, references will be provided and the loading will be done at the time of

without need of any external module or program dependency.	execution.
At loading time, the entire program is loaded into memory and starts its execution.	Routines of the library are loaded into memory only when they are required in the program.

Answer to the question number (3)

a)

Fragmentation: Processes are stored and removed from memory, which creates free memory space, which are too small to use by other processes.

After sometimes, that processes not able to allocate to memory blocks because its small size and memory blocks always remain unused is called fragmentation. This type of problem happens during a dynamic memory allocation system when free blocks are quite small, so it is not able to fulfill any request.

Types of fragmentation: Two types of Fragmentation methods are:

1. External fragmentation

2. Internal fragmentation

- External fragmentation can be reduced by rearranging memory contents to place all free memory together in a single block.
- The internal fragmentation can be reduced by assigning the smallest partition, which is still good enough to carry the entire process.

b)

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.

How virtual memory works: In the modern world, virtual memory has become quite common these days. It is used whenever some pages require to be loaded in the main memory for the execution, and the memory is not available for those many pages.

So, in that case, instead of preventing pages from entering in the main memory, the OS searches for the RAM space that are minimum used in the recent times or that are not referenced into the secondary memory to make the space for the new pages in the main memory.

c)

Benefits of having Virtual Memory:

1. Large programs can be written, as the virtual space available is huge compared to physical memory.
2. Less I/O required leads to faster and easy swapping of processes.
3. More physical memory available, as programs are stored on virtual memory, so they occupy very less space on actual physical memory.
4. Therefore, the Logical address space can be much more larger than that of physical address space.
5. Virtual memory allows address spaces to be shared by several processes

a)

Advantages of Virtual Memory are given bellow:

- Virtual Memory allows you to run more applications at a time.
- With the help of virtual memory, you can easily fit many large programs into smaller programs.
- With the help of Virtual memory, a multiprogramming environment can be easily implemented.
- As more processes should be maintained in the main memory which leads to the effective utilization of the CPU.
- Data should be read from disk at the time when required.
- Common data can be shared easily between memory.

b)

Memory Management Techniques:

Here, are some most crucial memory management techniques:

Single Contiguous Allocation

It is the easiest memory management technique. In this method, all types of computer's memory except a small portion which is reserved for the OS is available for one application. For example, MS-DOS operating system allocates memory in this way. An embedded system also runs on a single application.

Partitioned Allocation

It divides primary memory into various memory partitions, which is mostly contiguous areas of memory. Every partition stores all the information for a specific task or job. This method consists of allotting a partition to a job when it starts & unallocate when it ends.

Paged Memory Management

This method divides the computer's main memory into fixed-size units known as page frames. This hardware memory management unit maps pages into frames which should be allocated on a page basis.

c)

FIFO Page Replacement Algorithm:

It is a very simple way of Page replacement and is referred to as First in First Out. This algorithm mainly replaces the oldest page that has been present in the main memory for the longest time.

- This algorithm is implemented by keeping the track of all the pages in the queue.

- As new pages are requested and are swapped in, they are added to the tail of a queue and the page which is at the head becomes the victim.
- This is not an effective way of page replacement but it can be used for small systems.

Advantages

- This algorithm is simple and easy to use.
- FIFO does not cause more overhead.

Answer to the question number (5)

a)

Types of Page Replacement Methods:

Here, are some important Page replacement methods

- FIFO

- Optimal Algorithm
- LRU Page Replacement

FIFO Page Replacement

FIFO (First-in-first-out) is a simple implementation method. In this method, memory selects the page for a replacement that has been in the virtual address of the memory for the longest time.

Features:

- Whenever a new page loaded, the page recently comes in the memory is removed. So, it is easy to decide which page requires to be removed as its identification number is always at the FIFO stack.
- The oldest page in the main memory is one that should be selected for replacement first.

Optimal Algorithm

The optimal page replacement method selects that page for a replacement for which the time to the next reference is the longest.

Features:

- Optimal algorithm results in the fewest number of page faults. This algorithm is difficult to implement.
- An optimal page-replacement algorithm method has the lowest page-fault rate of all algorithms. This algorithm exists and which should be called MIN or OPT.
- Replace the page which unlike to use for a longer period of time. It only uses the time when a page needs to be used.

LRU Page Replacement

The full form of LRU is the Least Recently Used page. This method helps OS to find page usage over a short period of time. This algorithm should be implemented by associating a counter with an even- page.

Features:

- The LRU replacement method has the highest count. This counter is also called aging registers, which specify their age and how much their associated pages should also be referenced.
- The page which hasn't been used for the longest time in the main memory is the one that should be selected for replacement.
- It also keeps a list and replaces pages by looking back into time.

b)

Demand Paging:

The basic idea behind demand paging is that when a process is swapped in, its pages are not swapped in all at once. Rather they are swapped in only when the process needs them(On-demand). Initially, only those pages are loaded which will be required by the process immediately.

The pages that are not moved into the memory, are marked as invalid in the page table. For an invalid entry, the rest of the table is empty. In the case of pages that are loaded in the memory, they are marked as valid along with the information about where to find the swapped out page.

Thrashing:

A process that is spending more time paging than executing is said to be thrashing. In other words, it means, that the process doesn't have enough frames to hold all the pages for its execution, so it is swapping pages in and out very frequently to keep executing. Sometimes, the pages which will be required in the near future have to be swapped out.

Initially , when the CPU utilization is low, the process scheduling mechanism, to increase the level of multiprogramming loads multiple processes into the memory at the same time, allocating a limited amount of frames to each process. As the memory fills up, the process starts to spend a lot of time for the required pages to be swapped in, again leading to low CPU utilization because most of the processes are waiting for pages.

c)

Need of Virtual Memory:

Following are the reasons due to which there is a need for Virtual Memory:

- In case, if a computer running the Windows operating system needs more memory or RAM than the memory installed in the system then it uses a small portion of the hard drive for this purpose.
- Suppose there is a situation when your computer does not have space in the physical memory, then it writes things that it needs to remember into the hard disk in a swap file and that as virtual memory.

a)

File system:

A file is a collection of correlated information which is recorded on secondary or non-volatile storage like magnetic disks, optical disks, and tapes. It is a method of data collection that is used as a medium for giving input and receiving output from that program.

In general, a file is a sequence of bits, bytes, or records whose meaning is defined by the file creator and user. Every File has a logical location where they are located for storage and retrieval.

Objective of File management System:

Here are the main objectives of the file management system:

- It provides I/O support for a variety of storage device types.
- Minimizes the chances of lost or destroyed data
- Helps OS to standardized I/O interface routines for user processes.
- It provides I/O support for multiple users in a multiuser systems environment.

b)

Functions of file:

- Create file, find space on disk, and make an entry in the directory.
- Write to file, requires positioning within the file
- Read from file involves positioning within the file
- Delete directory entry, regain disk space.
- Reposition: move read/write position.

c)

Commonly used terms in File systems:

Field:

This element stores a single value, which can be static or variable length.

Database:

Collection of related data is called a database. Relationships among elements of data are explicit.

Files:

Files is the collection of similar record which is treated as a single entity.

Record:

A Record type is a complex data type that allows the programmer to create a new data type with the desired column structure. Its groups one or more columns to form a new data type. These columns will have their own names and data type.

Answer to the question number (7)

a)

File Access Methods:

File access is a process that determines the way that files are accessed and read into memory. Generally, a single access method is always supported by operating systems. Though there are some operating system which also supports multiple access methods.

Three file access methods are:

- Sequential access
- Direct random access
- Index sequential access

Sequential Access

In this type of file access method, records are accessed in a certain pre-defined sequence. In the sequential access method, information stored in the file is also processed one by one. Most compilers access files using this access method.

Random Access

The random access method is also called direct random access. This method allow accessing the record directly. Each record has its own address on which can be directly accessed for reading and writing.

Index Sequential Access

This type of accessing method is based on simple sequential access. In this access method, an index is built for every file, with a direct pointer to different memory blocks. In this method, the Index is searched sequentially, and its pointer can access the file directly. Multiple levels of indexing can be used to offer greater efficiency in access. It also reduces the time needed to access a single record.

b)

Three types of space allocation methods are:

- Linked Allocation
- Indexed Allocation
- Contiguous Allocation

Contiguous Allocation

In this method,

- Every file users a contiguous address space on memory.
- Here, the OS assigns disk address is in linear order.
- In the contiguous allocation method, external fragmentation is the biggest issue.

Linked Allocation

In this method,

- Every file includes a list of links.
- The directory contains a link or pointer in the first block of a file.
- With this method, there is no external fragmentation
- This File allocation method is used for sequential access files.
- This method is not ideal for a direct access file.

Indexed Allocation

In this method,

- Directory comprises the addresses of index blocks of the specific files.
- An index block is created, having all the pointers for specific files.
- All files should have individual index blocks to store the addresses for disk space.

c)

File Directories:

A single directory may or may not contain multiple files. It can also have sub-directories inside the main directory. Information about files is maintained by Directories. In Windows OS, it is called folders.

Following is the information which is maintained in a directory:

- **Name** The name which is displayed to the user.
- **Type**: Type of the directory.
- **Position**: Current next-read/write pointers.
- **Location**: Location on the device where the file header is stored.
- **Size** : Number of bytes, block, and words in the file.
- **Protection**: Access control on read/write/execute/delete.
- **Usage**: Time of creation, access, modification

a)

file structure:

A File Structure needs to be predefined format in such a way that an operating system understands . It has an exclusively defined structure, which is based on its type.

Three types of files structure in OS:

- A text file: It is a series of characters that is organized in lines.
- An object file: It is a series of bytes that is organized into blocks.
- A source file: It is a series of functions and processes.

b)

File system layer:

- Device drivers manage I/O devices at the I/O control layer
  - Given commands like "read drive1, cylinder 72, track 2, sectorλ 10, into memory location   1060" outputs low-level hardware specific commands to hardware controller
- Basic file system given command like "retrieve block 123"ν translates to device driver
- Also manages memory buffers and caches (allocation, freeing,ν replacement)
  - Buffers hold data in transit
  - Caches hold frequently used data
- File organization module understands files, logical address, and physical blocks
- Translates logical block # to physical block #
- Manages free space, disk allocatio
- Logical file system manages metadata information
  - Translates file name into file number, file handle, location byλ maintaining file control blocks (inodes in UNIX)
  - Directory managementλ
  - Protection

c)

Advantages of Deadlock:

Here, are pros/benefits of using Deadlock method

- This situation works well for processes which perform a single burst of activity
- No preemption needed for Deadlock.
- Convenient method when applied to resources whose state can be saved and restored easily
- Feasible to enforce via compile-time checks
- Needs no run-time computation since the problem is solved in system design