What are the four components of a process? (4 points)

Stack (contains temporary data such as local variables, return addresses, and function parameters)
Heap (memory that is dynamically allocated during process runtime)
Data Section (contains global variables)
Text Section (program code)

What are the three strategies for selecting a free hole from a set of available holes? (1 point)
Choose one and shortly describe it. (2 points)

First-fit: Allocate the first hole that is big enough
Best-fit: Allocate the smallest hole that is big enough; must search entire list, unless ordered by size, produces the smallest leftover hole
Worst-fit: Allocate the largest hole; must also search entire list Produces the largest leftover hole

What are the two fundamental models of inter-process communication? (4 points)
(Describe them with several sentences for full mark!)

Shared Memory: An area of memory shared among the processes that wish to communicate. The communication is under the control of the users processes not the operating system. Major issues are to provide mechanism that will allow the user processes to synchronize their actions when they access shared memory.
Message Passing: Mechanism for processes to communicate and to synchronize their actions. Message system – processes communicate with each other without resorting to shared variables.
IPC facility provides two operations: send(message) and receive(message).
The message size is either fixed or variable.

What is a system call? (1 point)

Programming interface to the services provided by the OS.
Typically written in a high-level language (C or C++).
Mostly accessed by programs via a high-level Application Programming.
Interface (API) rather than direct system call use.

What is internal fragmentation and where it could happen? (2 points)

Internal Fragmentation: unused memory that is internal to a partition breaks the physical memory into fixed-size blocks (usually of base 2) and allocate memory in units based on block size. The memory allocated to a process may be slightly larger than the requested memory; this size difference is memory internal to a partition, but not being used.

What is the problem if all philosophers simultaneously pick up their left chopstick? (2 points)

If all philosophers pick up the left chopstick, it will leave no right chopstick for them to pick up, creating a deadlock while they all indefinitely wait for a right chopstick to become available.

What kernel data structure can be used for one technique of passing parameters to system calls? (2 point)

Stack

What are the three requirement a solution to the critical section problem must satisfy?
(6 points)

Mutual Exclusion - If process Pi is executing in its critical section, then no other processes can be executing in their critical sections.
Progress - If no process is executing in its critical section and there exist some processes that wish to enter their critical section, then the selection of the processes that will enter the critical section next cannot be postponed indefinitely.
Bounded Waiting - A bound must exist on the number of times that other processes are allowed to enter their critical sections after a process has made a request to enter its critical section and before that request is granted.

What is the term for describing the situation where shared data may be manipulated concurrently and the outcome of the execution depends upon the order of access? (1 point)

Race condition

What are the attributes of a file or directory? (3 points)

Name – only information kept in human-readable form
Identifier – unique tag (number) identifies file within file system
Type – needed for systems that support different types
Location – pointer to file location on device
Size – current file size
Protection – controls who can do reading, writing, executing
Time, date, and user identification – data for protection, security, and usage monitoring.

What are the pre-emptive and non-pre-emptive strategies for process scheduling? Shortly describe them (4 points)

Non-pre-emptive:
First-Come, First-Served (FCFS): The process that arrives first is scheduled first. Non-pre-emptive because once a process starts executing, it continues until it completes.
Shortest Job Next (SJN) or Shortest Job First (SJF): The process with the shortest burst time is scheduled first. Non-pre-emptive because once a process starts executing, it continues until it completes.
Priority Scheduling: Like pre-emptive priority scheduling, but pre-emption does not occur. The process with the highest priority runs until it completes or is blocked.

Pre-emptive:
Round Robin (RR): Each process is assigned a fixed time slot or quantum. If a process does not complete within its time quantum, it is moved to the back of the queue, and the next process in the queue is given the CPU.
Priority Scheduling: Each process is assigned a priority, and the process with the highest priority is scheduled first. Pre-emption can occur when a higher-priority process arrives.
Multilevel Queue Scheduling: Processes are divided into priority levels, and each level has its own scheduling algorithm. Pre-emption can occur when a higher-priority process arrives or based on the time quantum.

What is paging? (2 points)

Memory management technique that divides physical memory into fixed-size blocks called pages, allowing OS to manage memory easier. Used in virtual memory.

What are the readers-writers problem? (2 points)

If two readers access the shared data simultaneously, no adverse effects will result. However, if a writer and some other process (either a reader or a writer) access the database simultaneously, chaos may ensue. To ensure that these difficulties do not arise, we require that the writers have exclusive access to the shared database while writing to the database.

What is the CPU-I/O Burst Cycle? (2 points)

Pattern where the CPU performs computations and then wait for input/output operations to finish. This cycle repeats as the program runs and interacts with external devices.

Just as a file must be opened before it is used, a file system must be ..... before it can be available to process on the system.

Mounted

What is the term for describing the situation where a waiting process is never again able to change state, because the resources it has requested are held by other waiting processes?

Deadlock

What are the fundamental components of the Process Control Block?
Describe a few of it with sentences for full mark. (4 points)

Process state. The state may be new, ready, running, waiting, halted, and so on.
Program counter. The counter indicates the address of the next instruction to be executed for this process.
Memory-management information. This information may include such items as the value of the base and limit registers and the page tables, or the segment tables, depending on the memory system used by the operating system.
CPU register: small, fast storage unit in the CPU used to hold data and instruction being processed and provide quick access to frequently used information, improving the efficiency of CPU operations.

What is a context switch? (1 point)

Switching the CPU to another process requires performing a state save of the current process and a state restore of a different process.

What is external fragmentation and where could it happen? (2 points)

Total memory space exists to satisfy a request, but it is not contiguous. It happens in stored system or operating systems.

What is Shortest Remaining Time, SRT scheduling? (2 points)

Shortest Remaining Time, SRT is a pre-emptive scheduling. In SRT, the process with smallest runtime to complete (i.e. remaining time) is scheduled to run next, including new arrivals.

A program that has been loaded and executing is called a_____. (1 point)

Process

Explain semaphores with details! Describe its types, operations and their short pseudo-code for full mark. (6 points)

Synchronization tool that provides more sophisticated ways (than Mutex locks) for process to synchronize their activities.
Types: Binary and Counting semaphores
Operations: wait() and signal()
Pseudo-codes:

```
wait(S) {
   while (S <= 0)
     ; // busy wait
   S--;
}
```

```
signal(S) {
    S++;
}
```

What are the strategies for disk scheduling? (1 point)
Choose one and shortly describe it. (2 points)

First-Come, First-Served (FCFS): The requests are serviced in the order they arrive in the queue.
Shortest Seek Time First (SSTF): The request with the shortest seek time is serviced first.
SCAN (Elevator) Algorithm: The disk arm moves in one direction and services requests along the way. When it reaches the end, it reverses direction.
C-SCAN (Circular SCAN) Algorithm: Like SCAN, but the arm moves only in one direction. Once it reaches the end, it jumps to the beginning of the disk.
C-LOOK Algorithm: Like C-SCAN, but the arm only reverses direction when there are no more requests in the current direction.

What is segmentation? (2 points)

Memory-management scheme that supports user view of memory. A program is a collection of segments
A segment is a logical unit such as: main program, procedure, function, method, object, local variables, global variables, common block, stack, symbol table, arrays.

Breaking logical memory into blocks of the same size called_____. (1 point)

Pages

What is the term for describing the situation where a process can be temporarily out of memory to a backing store and then brought back into memory for continued execution? (1 point)

Swapping

What are the typical attributes in a PCB? (3 points)
(Describe them with one sentence for full mark!)

Code, Stack, Data – From MCQ centre

Process state. The state may be new, ready, running, waiting, halted, and so on.
Program counter. The counter indicates the address of the next instruction to be executed for this process.
Memory-management information. This information may include such items as the value of the base and limit registers and the page tables, or the segment tables, depending on the memory system used by the operating system.
CPU register: small, fast storage unit in the CPU used to hold data and instruction being processed and provide quick access to frequently used information, improving the efficiency of CPU operations.

Describe the term "link" in the file system context. (2 points)

Link – another name (pointer) to an existing file.

A *link* is effectively a pointer to another file or subdirectory. For example, a link may be implemented as an absolute or a relative path name. When a reference to a file is made, we search the directory. If the directory entry is marked as a link, then the name of the real file is included in the link information.

What is the absolute and the relative path? (2 points)

Path names can be of two types: absolute and relative. An *absolute path* name begins at the root and follows a path down to the specified file, giving the directory names on the path. A *relative path* name defines a path from the current directory.