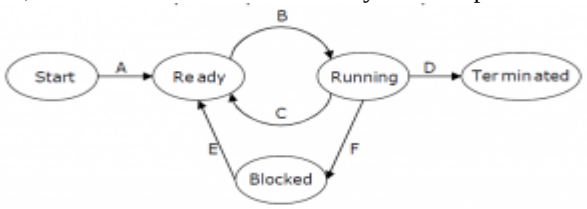
S. No.	Question	Blooms Taxonomy Level	Course Outcomes
	UNIT – I		
	PART – A (Short Answer Questions)		
1	**Define** operating system?	Knowledge	1
2	**Discuss** batch systems?	Understand	1
3	**List** any four functions of operating system?	Knowledge	1
4	**Define** system call?	Knowledge	1
5	**List** any four types of system calls?	Knowledge	1
6	**Distinguish** between user mode and kernel mode operations of the operating system?	Understand	1
7	**List** the advantages of multiprogramming?	Knowledge	1
8	**Distinguish** between multiprogramming and multitasking?	Understand	1
9	**Define** interrupt?	Knowledge	1
10	**Define** distributed systems?	Knowledge	1
11	**Define** real-time operating system?	Knowledge	1
12	**Define** virtual machine?	Knowledge	1
13	**List** the memory hierarchy available in operating system?	Knowledge	1
14	**Define** multiprocessor system?	Knowledge	1
15	**Describe** the different types of multiprocessing?	Knowledge	1
16	**Describe** the different types of multiprocessor systems?	Knowledge	1
17	**Define** kernel?	Knowledge	1

18	**Define** time-sharing systems?	Knowledge	1
19	**Describe** the use of fork () and exec () system calls?	Knowledge	1
20	**Define** privileged instructions?	Knowledge	1
21	**State** the differences between system call and system program?	Knowledge	1
22	**State** the five major activities of an operating system in regard to process management?	Knowledge	1
23	**State** the main advantage of the layered approach to system design? what are the disadvantages of using the layered approach?	Knowledge	1
24	**List** the contemporary operating systems that use the microkernel approach?	Knowledge	1
25	**List** the various OS components?	Knowledge	1
26	**State** the challenges in designing a distributed operating system?	Knowledge	1
	PART-B (Long Answer Questions)		
1	**State** and explain various types of computer systems?	Knowledge	1
2	a) **Define** an operating system? State and explain the basic functions or services of an operating system? b) **Explain** the differences between multiprogramming and time-sharing systems?	Understand	1
3	**Explain** how protection is provided for the hardware resources by the operating system?	Understand	1
4	**Describe** the system components of an operating system and **explain** them briefly?	Understand	1
5	**Describe** the operating system structures?	Knowledge	1
6	**Discuss** the following structures of OS?		1
7	**Explain** briefly system calls with examples?	Understand	1
8	**Define** the essential properties of the following operating systems?		1
9	a) **Explain** the architecture of an operating system? b) **Draw** and explain the architecture of windows 2000 and traditional UNIX?	Understand	1
10	Computer system architecture deals about how the component of a computer system may be organized? **Discuss** in detail about different architectures of a computer system?	Understand	1
11	Does an operating system generally need to keep about running processes in order to execute them? **Explain** in detail.	Understand	1
12	**Discuss** the view of an operating system as a resource manager?	Understand	1
13	**Distinguish** between multiprogramming, multitasking and multiprocessing?	Understand	1
14	**Explain** how operating system services are provided by system calls?	Understand	1
15	**Describe** the functionalities listed below? a) Batch programming b) Virtual Memory c) Time sharing	Knowledge	1
16	**Distinguish** between the client-server and peer-to-peer models of distributed systems?	Understand	1
	PART-C (Problem Solving and Critical Thinking)		
1	How does the distinction between kernel mode and user mode function as a rudimentary form of protection (security) system? **Justify.**	Knowledge	1
2	**Explain** using a simple system call as an example (e.g. getpid, or uptime), what is generally involved in providing the result, from the point of calling the function in the C library to the point where that function returns?	Understand	1
3	In a multiprogramming and time-sharing environment, several users share the system simultaneously. This situation can result in various security problems? a) **Explain** two such problems? b) Can we ensure the same degree of security in a time-shared machine as we have in a dedicated machine? **Explain** your answer.	Knowledge	1

4	**Explain** why must the operating system be more careful when accessing input to a system call (or producing the result) when the data is in memory instead of registers?	Understand	1
5	**Discuss** how a multi-threaded application can be supported by a user- level threads package. It may be helpful to consider (and draw) the components of such a package, and the function they perform?	Understand	1
6	**Explain** why do you think that idleness in CPU occurs?	Knowledge	1
7	**Explain** If you run the same program twice, what section would be shared in the memory?	Knowledge	1
8	**Explain** the difference between interrupt and exception?	Understand	1
9	**Differentiate** between tightly coupled systems and loosely coupled systems.	Knowledge	1
10	**Explain** Is OS is a resource manager? If so justify your answer	Knowledge	1
	UNIT – II		
	PART – A (Short Answer Questions)		
1	**Define** process. what is the information maintained in a PCB?	Knowledge	2
2	**Define** process state and mention the various states of a process?	Knowledge	2
3	**Describe** context switching?	Knowledge	2
4	**Explain** the use of job queues, ready queues and device queues?	Understand	2
5	**Distinguish** between thread with process?	Understand	2
6	**Explain** benefits of multithreaded programming?	Understand	2
7	**Explain** different ways in which a thread can be cancelled?	Understand	2
8	**Distinguish** between user threads and kernel threads?	Understand	2
9	**Define** CPU scheduling?	Knowledge	2
10	**List** the various scheduling criteria for CPU scheduling?	Knowledge	2
11	**Distinguish** between preemptive and non-preemptive scheduling techniques?	Understand	2
12	**Define** turnaround time?	Knowledge	2
13	**List** different types of scheduling algorithms?	Knowledge	2
14	**State** critical section problem?	Knowledge	2
15	**State** the requirements that a solution to the critical section problem must satisfy?	Knowledge	2
16	**Define** race condition?	Knowledge	2
17	**Define** semaphores. Mention its importance in operating system?	Knowledge	2
18	**State** two hardware instructions and their definitions which can be used for implementing mutual exclusion?	Knowledge	2
19	**Explain** bounded waiting in critical region?	Understand	2
20	**Distinguish** between semaphore and binary semaphore?	Understand	2
21	**Define** monitor?	Knowledge	2
22	**Describe** entry and exit sections of a critical section?	Knowledge	2
23	**State** the real difficulty with the implementation of the SJF CPU scheduling algorithm?	Knowledge	2
24	**State** the factors on which the performance of the Round Robin CPU scheduling algorithm depends?	Knowledge	2
25	**Name** the algorithms used for foreground and background queue scheduling in a multilevel queue-scheduling algorithm?	Knowledge	2
26	**State** the assumption behind the bounded buffer producer consumer problem?	Knowledge	2
	PART-B (Long Answer Questions)		
1	**Explain** the reasons for process termination?	Understand	2

2	**Discuss** the following process, program, process state, process control block, and process scheduling?	Understand	2
3	**Explain** the process state transition diagram with examples.	Understand	2
4	**Discuss** the attributes of the process. **Describe** the typical elements of process control block?	Understand	2
5	**Explain** the principles of concurrency and the execution of concurrent processes with a simple example?	Understand	2
6	**Describe** dining-philosophers problem? Device an algorithm to solve the problem using semaphores?	Understand	2
7	**Explain** the infinite buffer producer/consumer problem for concurrent processing which uses binary semaphores?	Understand	2
8	Define monitor? Distinguish between monitor and semaphore. **Explain** in detail a monitor with notify and broadcast functions using an example?	Understand	2
9	List out the various process states and briefly **explain** the same with a state diagram?	Understand	2
10	a) Describe process scheduling? **Explain** the various levels of scheduling. b) **Distinguish** pre-emptive and non-pre-emptive scheduling algorithms?	Understand	2
11	**Discuss** about following? a) Process b) Components of process c) Program versus process d) Process states	Understand	2
12	**Discuss** the following? a) CPU-I/O burst cycle b) CPU schedule c) Pre-emptive and non-preemptive scheduling d) Dispatcher	Understand	2
13	**Explain** the concept of multi-threading? Discuss the following multi-threading models. a) Many-to-one b) One-to-one c) Many-to-many d) Two-level	Understand	2
14	**Explain** the issues that may rise in multi-threading programming. Discuss about each in detail?	Understand	2
15	**Discuss** the following CPU scheduling algorithms a) Round robin b) Multilevel- queue scheduling c) Multi-level feedback queue scheduling	Understand	2
16	A scheduling mechanism should consider various scheduling criteria to realize the scheduling objectives? **List** out all the criteria.	Knowledge	2
17	Define semaphore? **Explain** the method of application of semaphore for process synchronization?	Understand	2
18	**Explain** the Readers and Writers problem and its solution using the concept of semaphores?	Understand	2
19	**Explain** the uses of the following: a. Mutex object b. Semaphore object c. Waitable timer object	Understand	2
20	**Write** short notes about the following: a. Binary Semaphores b. Bounded Waiting	Knowledge	2
PART-C (Problem Solving and Critical Thinking)			

<table>
<tr><td>1</td><td>Suppose we have a single processor system, and jobs arrive at a rate of 10 jobs a Seconds, suppose each job takes an average of 50 milli-seconds to complete. Assure that both distributions are exponential. State the expected number of jobs in the system and the average time in the system?</td><td>Knowledge</td><td>2</td></tr>
<tr><td>2</td><td>Suppose the following jobs arrive for processing at the times indicated, each job will run the listed amount of time.
<table><tr><th>Jobs</th><th>Arrival Time</th><th>Burst Time (in secs)</th></tr><tr><td>1</td><td>0.0</td><td>8</td></tr><tr><td>2</td><td>0.4</td><td>4</td></tr><tr><td>3</td><td>1.0</td><td>1</td></tr></table>Give Gantt chart illustrating the execution of these jobs using the non-pre-emptive FCFS and SJF scheduling algorithms. Compute the average turnaround time and average waiting time of each job for above algorithms.</td><td>Knowledge</td><td>2</td></tr>
<tr><td>3</td><td>Consider system with five processor P0 to P4 and 3 resources A, B and C, Resources type A has 10 instances, B has 5 instances and C has 7 instances. The snapshot at time T0 is
<table><tr><th></th><th colspan="3">ALLOTED</th><th colspan="3">MAX</th></tr><tr><th></th><th>A</th><th>B</th><th>C</th><th>A</th><th>B</th><th>C</th></tr><tr><td>P0</td><td>0</td><td>1</td><td>0</td><td>7</td><td>5</td><td>3</td></tr><tr><td>P1</td><td>2</td><td>0</td><td>0</td><td>3</td><td>2</td><td>2</td></tr><tr><td>P2</td><td>3</td><td>0</td><td>2</td><td>9</td><td>0</td><td>2</td></tr><tr><td>P3</td><td>2</td><td>1</td><td>1</td><td>2</td><td>2</td><td>2</td></tr><tr><td>P4</td><td>0</td><td>0</td><td>2</td><td>4</td><td>3</td><td>3</td></tr></table>Now the process P1 request one additional resource type A and two instances of C. Determine whether this new site is safe or not.</td><td>Knowledge</td><td>2</td></tr>
<tr><td>4</td><td>Explain the advantage of using semaphores over Test And Set () and Swap () functions. Describe the use of wait() and signal() functions on semaphore and how these can provide the solution to the Critical section problem?</td><td>Understand</td><td>2</td></tr>
<tr><td>5</td><td>Consider the following set of processes with the length of the CPU burst time given in milliseconds
<table><tr><th>Process</th><th>BurstTime</th><th>Priority</th></tr><tr><td>P1</td><td>10</td><td>3</td></tr><tr><td>P2</td><td>1</td><td>1</td></tr><tr><td>P3</td><td>2</td><td>3</td></tr><tr><td>P4</td><td>1</td><td>4</td></tr><tr><td>P5</td><td>5</td><td>2</td></tr></table>The processes are assumed to have arrived in the order p1, p2, p3, p4, p5 all at time 0.
a) Draw four Gantt charts illustrating the execution of these processes using FCFS, SJF, anon pre-emptive priority (a smaller priority number implies a higher priority) and RR (quantum=1) scheduling.
b) What is the turnaround time of each process for each of the scheduling algorithms in part?
c) What is the waiting time of each process for each of the scheduling algorithms in part? Which of the schedules in part a results in the minimal average waiting time?</td><td>Understand</td><td>2</td></tr>
<tr><td>6</td><td>Consider three processes (process id 0, 1, 2 respectively) with compute time bursts 2, 4 and 8 time units. All processes arrive at time zero. Consider the longest remaining time first (LRTF) scheduling algorithm. In LRTF ties are broken by giving priority to the process with the lowest process id. The average turnaround time is?</td><td>Understand</td><td>2</td></tr>
</table>

7	**Consider** three CPU-intensive processes, which require 10, 20 and 30 time units and arrive at times 0, 2 and 6, respectively. How many context switches are needed if the operating system implements a shortest remaining time first scheduling algorithm? Do not count the context switches at time zero and at the end	Knowledge	2
8	**Explain** the following process state transition diagram for a uniprocessor system, assume that there are always some processes in the ready  state	Understand	2
9	**Explain** Four jobs to be executed on a single processor system arrive at time 0 in the order A, B, C, D. their burst CPU time requirements are 4, 1, 8, 1 time units respectively. The completion time of A under round robin scheduling with time slice of one time unit is?	Knowledge	2
10	**Explain** Which scheduling algorithm allocates the CPU first to the process that requests the CPU first?	Understand	2
	UNIT – III		
	PART – A (Short Answer Questions)		
1	**Explain** the main function of the memory-management unit?	Understand	3
2	**Distinguish** between logical address and physical address?	Understand	3
3	**Describe** dynamic loading and dynamic linking?	Knowledge	3
4	**Distinguish** between compile time, load time and execution time address binding?	Understand	3
5	**Define** swapping?	Knowledge	3
6	**List** dynamic storage allocation strategies in contiguous memory allocation scheme?	Knowledge	3
7	**Distinguish** between MFT and MVT?	Understand	3
8	**Distinguish** between internal and external fragmentation?	Understand	3
9	**Define** compaction?	Knowledge	3
10	**List** and define non-contiguous memory allocation schemes?	Knowledge	3
11	**Distinguish** between paging and segmentation?	Understand	3
12	**State** the purpose of TLB?	Knowledge	3
13	**Explain** the basic approach of page replacement?	Understand	3
14	**Distinguish** between page table and inverted page table?	Understand	3
15	**State** the benefits of a virtual memory system?	Knowledge	3
16	**Distinguish** between demand paging and pure demand paging?	Understand	3
17	**Explain** the calculation of effective access time of a demand-paged memory system?	Understand	3
18	**Explain** page fault and its effect on the performance of the demand paged memory system?	Understand	3
19	**Explain** the need for page-replacement.?	Understand	3
20	**List** various page replacement algorithms?	Knowledge	3
21	**Distinguish** between local and global page replacement strategies?	Understand	3
22	**Distinguish** between equal and proportional frame allocation strategies?	Understand	3
23	**Explain** the concept of thrashing and why thrashing should be avoided in a system?	Understand	3
	PART-B (Long Answer Questions)		

1	**Describe** the following? a) Virtual Memory b) Cache Memory c) Auxiliary Memory	Understand	3
2	**Explain** in detail the requirements that memory management technique needs to satisfy?	Understand	3
3	**Explain** a) Paging b) Page table structure c) Translation look-aside buffer d) Segmentation	Understand	3
4	**Explain** why the "principle of locality" is crucial to the use of virtual memory? What is accomplished by page buffering?	Understand	3
5	**Discuss** briefly the swapping concept with necessary examples?	Understand	3
6	**Describe** contiguous memory allocation concept with advantages and disadvantages?	Knowledge	3
7	**Differentiate** the main memory organization schemes of contiguous-memory allocation, segmentation, and paging with respect to the following		3
8	**Differentiate** between internal and external fragmentation and Which one occurs in paging scheme?	Understand	3
9	**Explain** briefly about paging with neat diagram?	Understand	3
10	**Discuss** the following a) Hierarchical paging b) Inverted page Tables	Understand	3
11	Draw and **explain** the working procedure of paging hardware in detail?	Understand	3
12	**Explain** the basic concepts of segmentation with neat diagrams?	Understand	3
13	**Define** page fault? When does a page fault occur? Describe the action taken by OS when page fault occurs?	Knowledge	3
14	**State** and explain about virtual memory concept with neat diagram?	Knowledge	3
15	**Differentiate** between paging and segmentation?	Understand	3
16	**Explain** briefly the performance of demand paging with necessary examples?	Understand	3
17	**Explain** the basic Scheme of page replacement and about the various page replacement strategies with examples?	Understand	3
18	**Explain** the Readers and Writers problem and its solution using the concept of semaphores?	Understand	3
19	**Explain** the uses of the following: a. Mutex object b. Semaphore object c. Waitable timer object	Understand	3
20	**Write** short notes about the following: a. Binary Semaphores b. Bounded Waiting	Knowledge	3
21	**Explain** the Readers and Writers problem and its solution using the concept of semaphores?	Understand	3
PART-C (Problem Solving and Critical Thinking)			
1	Suppose you have 16M bytes of main memory. Using the list method there is an overhead of 8B per memory block. Using the bitmap method, the allocation granularity is of 128B. How many blocks are there when the space overhead of both methods is the same? **Explain** the average block size for this many blocks?	Knowledge	3

2	**Consider** a computer system supports 32-bit virtual addresses as well as 32-bit physical addresses. Since the virtual address space is of the same size as the physical address space, the operating system designers decide to get rid of the virtual memory entirely.	Knowledge	3
3	**Consider** a CPU generates 32-bit virtual addresses. The page size is 4 KB. The processor has a translation look-aside buffer (TLB) which can hold a total of 128 page table entries and is 4-way set associative. The minimum size of the TLB tag is:	Understand	3
4	**Consider** there are 3 page frames which are initially empty. If the page reference string is 1, 2, 3, 4, 2, 1, 5, 3, 2, 4, 6, the number of page faults using the optimal replacement policy is	Knowledge	3
5	**Consider** the following page reference string 7,0,2,0,3,0,4,2,3,0,3,2,1,2,0,1,7,0 Assuming three frames, how many page faults would occur in each of the following cases? a) LRU b) FIFO c) Optimal algorithms Note that initially all frames are empty.	Understand	3
6	**Analyze** that we have a paging system with page table stored in memory A. If a memory reference takes 200 nanoseconds how long does a paged B. If we add associative registers and 75% of all page table references are memory reference take found in the associative registers, what is the effective memory reference time? Assume that finding a page table entry in the associative registers takes zero time, if the entry is there.	Knowledge	3
7	In two level nested loops, the outer index (i) runs from 1 to 5 and the inner index (j) runs from 1 to 10.The page faults seem to occur for every 7^{th} innermost iterations. If it takes 0.02 micro second to load a new page what is the extra time required because of occurrence of page faults?	Knowledge	3
8	Given memory partitions of 100K, 500K, 200K, 300K, and 600K (in order), how would each of the First-fit, Best-fit, and Worst-fit algorithms place processes of 212K, 417K, 112K, and 426K (in order)? **Explain** Which algorithm makes the most efficient use of memory?	Understand	3
9	Suppose we have a demand paged memory. The page table is held in registers. It takes 8 milliseconds to service a page fault if an empty frame is available or the replaced page is not modified and 20 milliseconds if the replaced page is modified. Memory access time is 100 nanoseconds. **Consider** that the page to be replaced is modified 70 percent of the time. What is the maximum acceptable page-fault rate for an effective access time of no more than 200 nanoseconds?	Understand	3
10	**Consider** a logical address space of eight pages of 1024 words each mapped onto a physical memory of 32 frames a) How many bits are in the logical address? b) How many bits are in the physical address?	Knowledge	3
UNIT – IV			
PART – A (Short Answer Questions)			
1	**Define** the terms – file, file path, directory?	Knowledge	4
2	**Explain** any four common file attributes?	Understand	4
3	**Explain** any four file operations?	Understand	4
4	**Distinguish** between shared and exclusive lock?	Understand	4
5	**List** any four common file types and their extensions?	Knowledge	4
6	**Explain** the information associated with an open file?	Understand	4
7	**List** the different file accessing methods?	Knowledge	4
8	**Explain** the operations that can be performed on a directory?	Understand	4

9	**Discuss** the most common schemes for defining the logical structure of a directory?	Understand	4
10	**Describe** UFD and MFD.?	Knowledge	4
11	**Describe** file system mounting?	Knowledge	4
12	**Write** the format of a typical file-control block?	Knowledge	4
13	**List** the different disk-space allocation methods?	Knowledge	4
14	**List** the various layers of a file system?	Knowledge	4
15	**Explain** the functions of virtual file system (VFS)?	Understand	4
16	**Describe** about different types of disk scheduling?	Knowledge	4
17	**Define** the terms with respect to disk I/O - seek time, latency time?	Knowledge	4
18	**Explain** the allocation methods of a disk space?	Understand	4
19	**State** the advantages of linked disk-space allocation strategy?	Knowledge	4
20	**State** the advantages of indexed disk-space allocation strategy?	Knowledge	4
21	**List** the different free disk-space management techniques?	Knowledge	4
22	**Explain** the bit vector method free space management on disk?	Understand	4
23	**Discuss** the advantages of contiguous memory allocation of disk space?	Understand	4
24	**Discuss** the drawbacks of contiguous allocation of disk space?	Understand	4
25	**List** any four secondary storage memory devices?	Knowledge	4
26	**Describe** about logical formatting of the disk?	Knowledge	4
27	**List** various disk-scheduling algorithms?	Knowledge	4
28	**State** the purpose of boot block?	Knowledge	4
PART-B (Long Answer Questions)			
1	a) **Discuss** the criteria for choosing a file organization? b) **Describe** indexed file and indexed sequential file organization?	Understand	4
2	**Describe** the file system of UNIX?	Understand	4
3	**List** the common file types along with their extensions and describe each file type?	Knowledge	4
4	**Differentiate** among the following disk scheduling algorithms? a) FCFS b) SSTF c) SCAN d) C-SCAN e) LOOK f) C-LOOK	Understand	4
5	a) **Explain** magnetic disk structure and its management? b) **Exemplify** swap space management?	Understand	4
6	**Explain** the following in detail with respect to disk? a) Seek time b) Latency c) Access time d) Transfer time	Understand	4
7	a) **Explain** in detail the interrupts and interrupt handling features? b) **Explain** with neat diagram the steps in DMA transfer?	Understand	4
8	a) **Discuss** the N-step SCAN policy for disk scheduling? b) **Explain** how double buffering improves the performance than a single buffer for I/O?	Understand	4
9	a) **Explain** the techniques used for performing I/O? b) Give an example of an application in which data in a file should be accessed in the following order: i. sequential ii. Random	Understand	4
10	**Discuss** in detail the performance issues of secondary storage management?	Understand	4

11	**Explain** how disk caching can improve disk performance?	Understand	4
12	**Explain** low-level formatting or physical formatting?	Understand	4
13	**Define** buffering, caching and spooling?	Knowledge	4
14	**Discuss** the following a) File system mounting b) Thrashing	Understand	4
15	**Explain** the following file concepts: a) File attributes b) File operations c) File types d) Internal file structure	Understand	4
16	**Explain** the concept of file sharing? What are the criteria to be followed in systems which implement file sharing?	Understand	4
17	**Describe** the following Directory Implementation methods? a) Linear List b) Hash Table	Knowledge	4
18	**Explain** the concept and techniques of free space management?	Understand	4
19	**Discuss** about a) Disk space management b) Swap -space management	Understand	4
PART-C (Problem Solving and Critical Thinking)			
1	Suppose we have files F1 to F4 in sizes of 7178, 572, 499 and 1195 bytes. Our disks have fixed physical block size of 512 bytes for allocation. **Explain h**ow many physical blocks would be needed to store these four files if we were to use a chained allocation strategy assuming that we need 5 bytes of information to determine the next block in the link? Which file results in the maximum internal fragmentation (measured as a percentage of the file size itself)?	Understand	4
2	**Using** a diagram, show how an indexed allocation of a file may be done for a disked based system with the following characteristics. The disc size is 30blocks each of 1024 bytes (may be modeled as 6 X 5 matrixes). File f1 is 11 logical records of 112 bytes, file f2 is 890 logical records of 13 bytes, file f3 is 510 bytes of binary data stream and file f4 is 4 logical blocks of 95 bytes.	Knowledge	4
3	A hard disk has 63 sectors per tracks, 10 platters each with 2 recording surfaces and 1000 cylinders. The address of a sector is given as a triple <c, h, and s> where c is the cylinder number, h is the surface number and s is the sector number. Thus 0th sector is addressed as <0, 0, and 0>, the 1st sector is Addressed as <0, 0, and 1> and so on. Calculate the address of 1050th sector.	Understand	4
4	**Explain** the maximum file size supported by a file system with 16 direct blocks, single, double, and triple indirection? The block size is 512 bytes. Disk block numbers can be stored in 4 bytes.	Understand	4
5	**Discuss** the reasons why the operating system might require accurate information on how blocks are stored on disk. how could operating system improves file system performance with this knowledge	Understand	4
6	**Discuss** how OS could maintain a free-space list for a tape-resident file system. Assume that the tape technology is append-only and that it uses EOT marks and locate, space and read position command	Understand	4
7	Is there any way to implement truly stable storage? **Explain** your answer	Understand	4
8	Could a RAID level 1 organization achieve better performance for read requests than RAID level 0 organization(with non redundant striping of data)? If so, how?	Understand	4
9	Compare the performance of write operations achieved by a RAID level 5 organization with that achieved by a RAID level 1 organization.	Understand	4

10	**Consider** that a disk drive has 5,000 cylinders, numbered 0 to 4,999. The drive is currently serving request at cylinder 143, and the previous request was at cylinder 125. The queue of pending requests, in FIFO order, is: 86, 1470, 913, 1774, 948, 1509, 1022, 1750, 130 Starting from the current head position, what is the total distance (in cylinders) that the disk arm moves to satisfy all pending requests for each of the following disk scheduling algorithms? A. FCFS B. SSTF C. SCAN D. C-SCAN E. LOOK F. C-LOOK	Knowledge	4
UNIT – V			
PART – A (Short Answer Questions)			
1	**Define** deadlock?	Knowledge	5
2	**Define** resource. List some resources that a process might need for its execution?	Knowledge	5
3	**Explain** the sequence in which a process may utilize the resources in normal mode of operation?	Understand	5
4	**Describe** the conditions under which a deadlock situation may arise?	Knowledge	5
5	**Explain** safe state and unsafe state?	Understand	5
6	**Describe** the representation of a resource-allocation graph?	Knowledge	5
7	**Distinguish** between deadlock avoidance and prevention strategies?	Understand	5
8	**Describe** the purpose of banker's algorithm?	Knowledge	5
9	**List** the four data structures (matrices) that must be maintained to implement banker's algorithm?	Knowledge	5
10	**Describe** the techniques for recovery from deadlock?	Knowledge	5
11	**List** the goals of protection?	Knowledge	5
12	**Define** the terms – object, domain, access right?	Knowledge	5
13	**Write** the format of an access matrix?	Knowledge	5
14	**List** the implementation techniques of access matrix?	Knowledge	5
15	**Describe** role-based access control?	Knowledge	5
16	**List** the schemes that implement revocation of capabilities?	Knowledge	5
17	**List** any two example systems that implement capability-based protection?	Knowledge	5
18	**Describe** any one language-based protection schemes.	Knowledge	5
19	**Write** the main differences between capability lists and access lists?	Knowledge	5
20	**State** the protection problems that may arise if a shared stack is used for parameter passing?	Knowledge	5
21	**State** principle of least privilege?	Knowledge	5
PART-B (Long Answer Questions)			
1	**Define** deadlock? what are the four conditions necessary for a deadlock situation to arise? how it can be prevented?	Knowledge	5
2	**Explain** briefly resource allocation graph with examples?	Understand	5
3	**Differentiate** the deadlock handling methods?	Understand	5
4	**Discuss** in detail the technique of deadlock avoidance?	Understand	5
5	**Explain** Banker's algorithm for deadlock avoidance with an example?	Understand	5
6	**Discuss** deadlock detection method in detail?	Understand	5
7	**State** and explain the methods involved in recovery from deadlocks?	Knowledge	5
8	Describe resource-allocation graph? **Explain** how resource graph can be used for detecting deadlocks?	Understand	5

<table>
<tr><td>9</td><td>Describe the terms.
a) Race condition
b) Atomic transaction
c) Critical section
d) Mutual exclusion</td><td>Knowledge</td><td>5</td></tr>
<tr><td>10</td><td>Describe how the access matrix facility and role-based access control facility are similar? how do they differ?</td><td>Knowledge</td><td>5</td></tr>
<tr><td>11</td><td>Explain why a capability based system such as Hydra provides greater flexibility than the ring- protection scheme in enforcing protection policies?</td><td>Understand</td><td>5</td></tr>
<tr><td>12</td><td>Explain the following.
a) Goals of protection
b) Principles of protection</td><td>Understand</td><td>5</td></tr>
<tr><td>13</td><td>Discuss about domain of protection?</td><td>Understand</td><td>5</td></tr>
<tr><td>14</td><td>Why do you need to provide protection to the system? Explain how access matrix can be used for the purpose?</td><td>Understand</td><td>5</td></tr>
<tr><td>15</td><td>Discuss the access matrix implementation techniques?</td><td>Understand</td><td>5</td></tr>
<tr><td>16</td><td>Compare the various access matrix implementation techniques?</td><td>Understand</td><td>5</td></tr>
<tr><td>17</td><td>Discuss the various issues that need to be considered through the process of revocation of access rights?</td><td>Understand</td><td>5</td></tr>
<tr><td>18</td><td>Explain various schemes to implement revocation for capabilities?</td><td>Understand</td><td>5</td></tr>
<tr><td>19</td><td>Explain how language-based protection scheme can be used for providing system protection at kernel level?</td><td>Understand</td><td>5</td></tr>
<tr><td>20</td><td>Explain relative merits of compiler-based enforcement based solely on a kernel, as opposed to enforcement provided largely by a compiler?</td><td>Understand</td><td>5</td></tr>
<tr><td colspan="4">PART-C (Problem Solving and Critical Thinking)</td></tr>
<tr><td>1</td><td>Consider the following snapshot of a system
<table>
<tr><td></td><td colspan="4">Allocation</td><td colspan="4">Max</td><td colspan="4">Available</td></tr>
<tr><td></td><td>A</td><td>B</td><td>C</td><td>D</td><td>A</td><td>B</td><td>C</td><td>D</td><td>A</td><td>B</td><td>C</td><td>D</td></tr>
<tr><td>P1</td><td>0</td><td>0</td><td>1</td><td>3</td><td>0</td><td>0</td><td>1</td><td>2</td><td>1</td><td>5</td><td>2</td><td>0</td></tr>
<tr><td>P2</td><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td><td>7</td><td>5</td><td>0</td><td></td><td></td><td></td><td></td></tr>
<tr><td>P3</td><td>1</td><td>3</td><td>5</td><td>4</td><td>2</td><td>3</td><td>5</td><td>6</td><td></td><td></td><td></td><td></td></tr>
</table>
Answer the following questions using the banker’s algorithm:
a) What is the content of matrix “Need”?
b) Is the system in a safe state?
c) If a request from process P1 arrives for (0, 4, 2, 0) can the request be granted immediately?</td><td>Knowledge</td><td>5</td></tr>
<tr><td>2</td><td>Consider the version of the dining-philosophers problem in which the chopsticks are placed at the center of the table and any two of them can be used by a philosopher. Assume that requests for chopsticks are made one at a time. Describe a simple rule for determining whether a particular request can be satisfied without causing deadlock given the current allocation of chopsticks to philosophers.</td><td>Knowledge</td><td>5</td></tr>
<tr><td>3</td><td>Consider a system consisting of m resources of the same type being shared by n processes. A process can request or release only one resource at a time. Show that the system is deadlock free if the following two conditions hold:
a) The maximum need of each process is between one resource and m resources.
b) The sum of all maximum needs is less than m + n.</td><td>Knowledge</td><td>5</td></tr>
<tr><td>4</td><td>Explain How does the principle of least privilege aid in the creation of protection systems?</td><td>Understand</td><td>5</td></tr>
<tr><td>5</td><td>Describe how the Java protection model would be compromised if a Java program were allowed to directly alter the annotations of its stack frame.</td><td>Knowledge</td><td>5</td></tr>
<tr><td>6</td><td>List the Coffman's conditions that lead to a deadlock.</td><td>Understand</td><td>5</td></tr>
</table>

7	A system has n resources R_0,...,R_{n-1},and k processes P_0,....P_{k-1}.The implementation of the resource request logic of each process P_i is as follows:
	if (i % 2 == 0)
	{
	if (i < n) request Ri
	if (i+2 < n) request Ri+2
	}
	else
	{
	if (i < n) request Rn-i
	if (i+2 < n) request Rn-i-2
	}
		Knowledge	5

8	A system contains three programs and each requires three tape units for its operation. **Explain** the minimum number of tape units which the system must have such that deadlocks never arise is?	Understand	5
9	A system has 6 identical resources and N processes competing for them. Each process can request atmost 2 resources. **Explain** which one of the following values of N could lead to a deadlock?	Remember	5
10	Two shared resources R_1 and R_2 are used by processes P_1 and P_2. Each process has a certain priority for accessing each resource. Let T_{ii} denote the priority of P_i for accessing R_i. A process $P_i$can snatch a resource R_h from process P_j if T_{ik} is greater than T_{jk}. Given the following : 1. $T_{11} > T_{21}$ 2. $T_{12} > T_{22}$ 3. $T_{11} < T_{21}$ 4. $T_{12} < T_{22}$ **Explain** which of the following conditions ensures that P_1 and P_2 can never deadlock?	Knowledge	5