FIle systems and Disk Scheduling

1) Consider a hard disk of capacity 1GB, and a block size of 1KB. If the free space list is maintained as a bitmap, then the size of the bitmap is
A) 1MB
B) 1Mb
C) 1Kb
D) 1KB

Solution: (B)
Each bit in bit maps represents a block. So no.of blocks = 1GB/1KB = 2^30/2^10 = 2^20 = 1M blocks. Each block takes 1 bit for representation so 1Mb of space is required.

2) Consider an index-based file system with the inode containing 64 direct, 1 indirect index block, and a doubly indirect index block. Assume that each index takes 4 bytes. The maximum file size under this arrangement, _____ KB, if a disk block is 1024 bytes?
[NAT]

Solution: 65856
Block size = 1024 bytes, so number of block pointers = 1024/4 = 256.
So maximum file size = (64+256+256*256)*1024 bytes = 65856KB

3) Consider a file system with 4096 byte blocks and 32-bit disk and file block pointers. Each file has 13 direct pointers, 4 singly-indirect pointers, a doubly-indirect pointer, and a triply-indirect pointer. In such a file system, the number of inodes that fit into a block is.....(NAT)
A. 53
B. 54
C. 51
D. 55

Solution: (A)
An inode has 13 + 4 + 1 + 1=19 pointers x 32bits(4Bytes) = 76bytes. So number of inodes/block = floor(4096/76) = 53

4) Disk requests come into the disk driver for cylinders: 10, 22, 20, 2, 40, 6, 38, in that order. The disk has 60 total cylinders and the disk head is currently positioned over cylinder 20. A seek takes 6 milliseconds per cylinder moved total seek time using LOOK disk scheduling algorithm is (initialing moving upwards):
A. 876
B. 348
C. 360
D. 640

Solution: (B)
Sequence 20,22, 38, 40, 10, 6, 2
0 + 2 + 16 + 2 + 30 + 4 + 4 = 58 cylinders * 6milliseconds = 348milliseconds

5) A unix i-node has 10 disk addresses for data blocks, as well as addresses of single, double and triple indirect blocks. If each of these indirect blocks hold 256 disk addresses, what is the approximate size of the largest file? Assume each disk block is 1K bytes size.
A. 2GB
B. 4GB
C. 8GB
D. 16GB

Solution: (D)
i-node holds 10 addresses – 10k
Single indirect block holds 256 addresses – 256k
Double indirect block leads to 256x256=65536 addresses – 65536k
Triple indirect – 65536x256=16777216 blocks – 16777216k
Total is 10 + 2**8 + 2**16 + 2**24 blocks of 1k bytes each,
16,843,018 blocks – 16 Gigabytes approximately.

6) A disk drive has 5000 cylinders, numbered 0 to 4999. The drive is serving a request at cylinder 143 currently and the previous request was at 125. The disk I/O queue, in FIFO order, is
86, 1470, 913, 1774, 948, 1509, 1022, 1750, 130
Starting from the current head position, the total distance (in cylinders) that the disk arm moves to satisfy all the pending requests was found to be 3319. Identify which scheduling method that was used?
A. FCFS
B. SSTF
C. SCAN
D. C-SCAN

Solution: (C)
FCFS: 143, 86, 1470, 913, 1774, 948, 1509, 1022, 1750, 130 – 7081
SSTF: 143, 130, 86, 913, 948, 1022, 1470, 1509, 1750, 1774 – 1745
SCAN: 143, 913, 948, 1022, 1470, 1509, 1750, 1774, 130, 86 – 3319
C-SCAN: 143, 913, 948, 1022, 1470, 1509, 1750, 1774, 86, 130 – 3363

7) The request queue for a disk contains the following requests in [track:sector] form: [10:5], [22:9], [20:21], [21:9], [2:10], [40:45], [6:7], [38:9] Assume that the disk head is currently positioned over cylinder 20. What is the sequence of reads under the Shortest Seek Time First head scheduling algorithm?

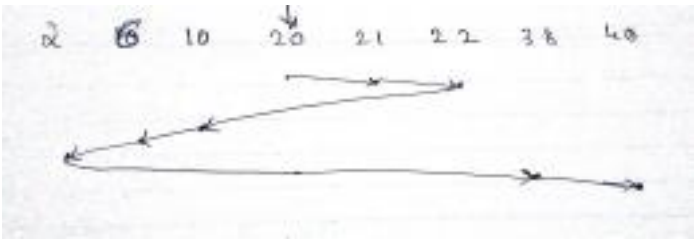
A. [20:21], [21:9], [22:9], [10:5], [6:7], [2:10], [38:9], [40:45]

B. [20:21], [21:9], [22:9], [38:9], [40:45], [10:5], [6:7], [2:10]

C. [40:45], [38:9], [2:10], [10:5], [6:7], [22:9], [21:9], [20:21]

D. None of these

Solution: (A)
Only the track numbers matter here.



8) Consider a file system with 2KB block size and 4 bytes block entry size. Each file can have 12 direct pointers, a singly indirect, a doubly indirect, and a triply indirect pointer. What is the maximum disk size supported by the system ?
A) 256GB
B) 512GB
C) 1TB
D) 8TB
Solution (D)
A 4byte = 32bits entry implies we can have 2^32 blocks on the disk. Each block is 2KB. Therefore, total disk size = 2^32*2KB = 2^43 bytes = 8TB.

9) The beginning of a free-space bitmap looks like this after the disk partition is first formatted: 1000 0000 0000 0000 (the first block is used by the root directory). The system always searches for free blocks starting at the lowest-numbered block, so after writing file A, which uses six blocks, the bitmap looks like this: 1111 1110 0000 0000. What the bitmap will look after each of the following additional actions:
(I) File B is written, using five blocks.
(II) File A is deleted.
(III) File C is written, using eight blocks.
(IV) File B is deleted.

A) 1111 1110 0000 1100
B) 1000 0001 1111 0000
C) 1111 0000 0000 1100
D) 1111 1110 0000 1000

Solution A)
After writing fileB: 1111 1111 1111 0000
After deleting fileA: 1000 0001 1111 0000
After writing fileC: 1111 1111 1111 1100
After deleting fileB: 1111 1110 0000 1100

10) In the indexed allocation, all the pointers of a file are brought together at one place in the_____.
A) data block
B) index block

C) indirect block
D) none

Solution (B)
In indexed allocation, each file is allocated an index block. An index block consists of block addresses of the file. In this way, all the pointers of a file are brought together into the index block. The index block is one separate disk block allocated to the file. The FAT entry will contain only the address of the index block of the file.

11) There is minimum disk head movement in _____ file allocation.
A) contiguous
B) indexed
C) linked
D) none

Solution (A)
In contiguous file allocation, there is no or minimum head movement when a job is accessing the blocks of the file. On the disk, suppose a file is stored on one track but continues on the next track. To access a block on a different track, head movement is needed only from one track to the next. Thus, seek time will be minimal.

12) What is 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.

A) 1GB
B) 48GB
C) 32GB
D) 16GB

Solution A)

Given Block size = 512 Bytes.
number of block numbers in an in direction block = block size / 4 = 128
Maximum file size = (direct + single indirect + double indirect + triple indirect) * (blocksize)
= (16 + 512/4 + (512/4)^2 + (512/4)^3) * (512)
=1082204160 = 1GB

13) Suppose that the head of a moving-head disk with 192 tracks, numbered 0 to 191, is currently serving a request at track 80 and has just finished a request at track 62. The queue of requests is kept in the FIFO order: 119, 58, 114, 28, 111, 55, 103, 30, 75. What is the total number of tracks traversed by head movements needed to satisfy these requests for the SSTF disk-scheduling algorithm?

A) 547
B) 143
C) 130

D) 177

Solution B)
(80-75)+(75-58)+(58-55)+(55-30)+(30-28)+(111-28)+(114-111)+(119-114) = 143.

14) Suppose that the head of a moving-head disk with 192 tracks, numbered 0 to 191, is currently serving a request at track 80 and has just finished a request at track 62. The queue of requests is kept in the FIFO order: 119, 58, 114, 28, 111, 55, 103, 30, 75. What is the total number of tracks traversed by head movements needed to satisfy these requests for the FCFS disk-scheduling algorithm?

A) 547
B) 143
C) 130
D) 177

Solution A) (119-80) + (119-58)+(114-58)+(114-28)+(111-28)+(111-55)+(103-55)+(103-30)+(75-30) = 547.

15) Consider a file system with 4096 byte blocks and 32-bit disk and file block pointers. Each file has 13 direct pointers, 4 singly-indirect pointers, a doubly-indirect pointer, and a triply-indirect pointer. The number of i-nodes that can fit in a single block are.....

A) 54
B) 53
C) 127
D) 128

Solution: (B)
Since block pointers are 32 bits, total size = $2^{32} \times 4096 = 2^{44}$bytes maximum.
An inode has 13 + 4 + 1 + 1 = 19 pointers = 19×32bits = 76 bytes.
Hence, the number of inodes per block = $\lfloor \frac{4096}{76} \rfloor = 53$.

16) Consider the following six I/O operations and their respective cylinder locations on disk. Seek time is 0.1ms per cylinder traversed and the arm begins at cylinder 33.

(A:4), (B:10), (C:35), (D:62), (E:69), (F:95)

Using the Shortest Seek Time First disk scheduling algorithm to schedule these operations, find the total seek time (in ms).
A) 12
B) 12.4
C) 11.5
D) 15

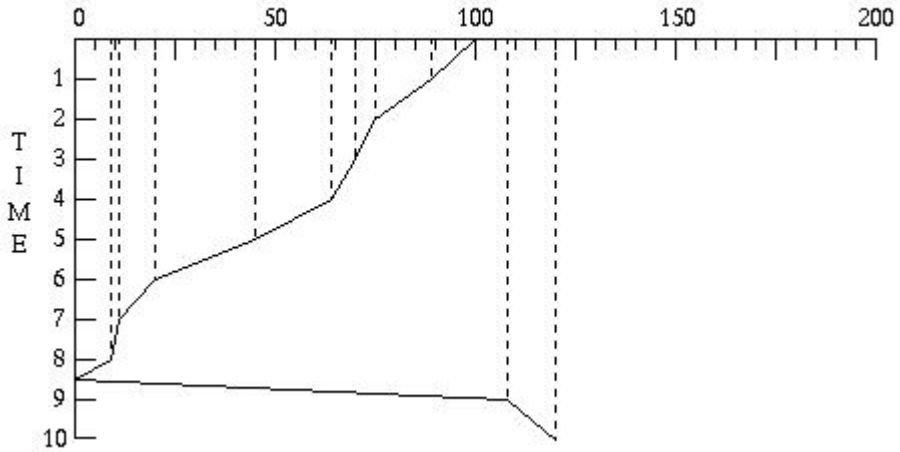
Solution: (B)

The sequence of access along seek time is given below

C (0.2), B (2.5), A (0.6), D (5.8), E (0.7), F (2.6) = 12.4 ms.

17) Suppose a file system can have three disk allocation strategies, contiguous, linked, and indexed. We have just read the information for a file from its parent directory. For contiguous and linked allocation, this gives the address of the first block, and for indexed allocation this gives the address of the index block. Now we want to read the Nth data block into the memory. How many disk blocks do we have to read for each of the allocation strategies? (contiguous, linked, and indexed)
A. 0, 1, and N
B. 1, N, and 0
C. 2, 1, and N
D. 1, N, and 2
Solution: (D)
Explanation:
Contiguous allocation: You can think of it as an array of blocks, hence we directly index into Nth block. So only 1 block access is needed.
Linked allocation: It is a linked list, to access an Nth block we do N traversals. So N block accesses are need
Indexed allocation: One access for Inode + One access for Block = 2.

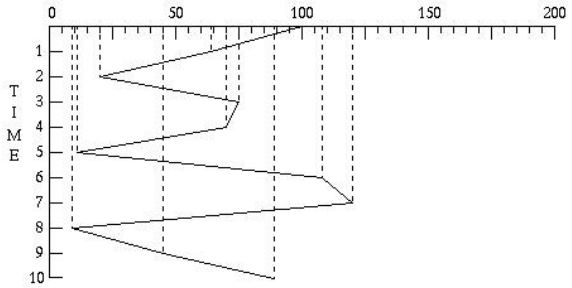
18) Consider the following requests for disk access: 64, 20, 75, 70, 11, 108, 120, 9, 45, 8. The tracks are numbered from 1-200, and the head is positioned at track 100. Identify the disk scheduling algorithm used, for which the below graph would have been obtained?



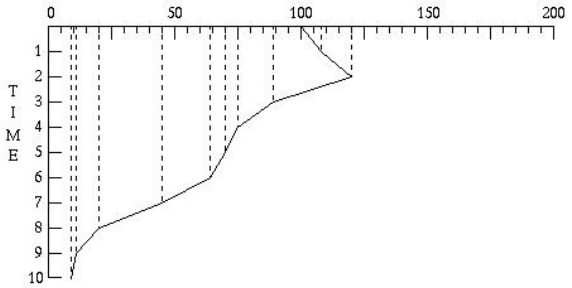
A) First Come First Serve
B) Shortest Seek Time First
C) SCAN (direction towards left)
D) C-SCAN (direction towards left)

Solution: (C)

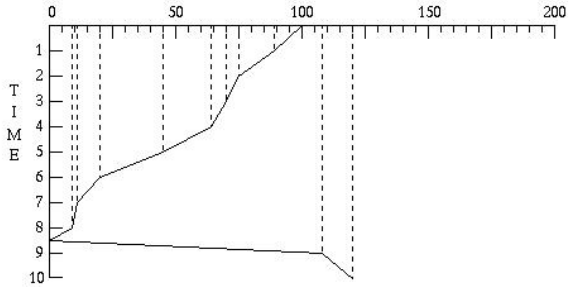
FCFS	SSTF

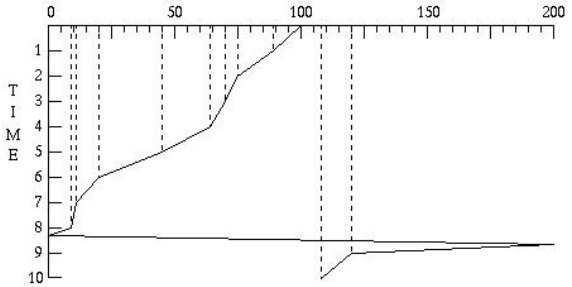


SCAN



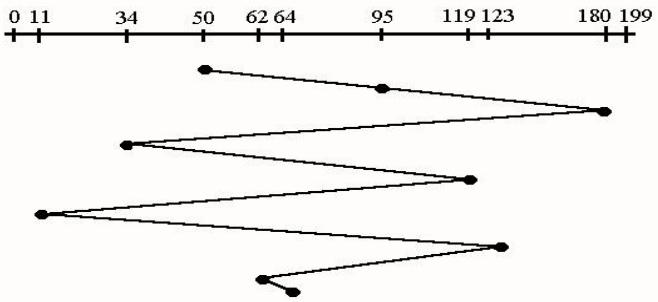
C-SCAN





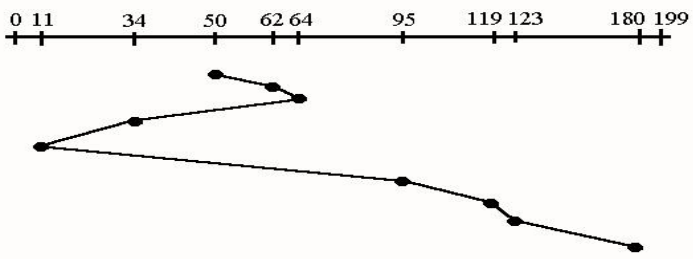
19) Given the following queue for disk requests -- 95, 180, 34, 119, 11, 123, 62, 64 with the read-write head initially at the track 50 and the tracks are labeled form 0-199. The total number of disk seeks for FCFS scheduling algorithm is_____ **[NAT]**

Solution: 640



20) Given the following queue for disk requests -- 95, 180, 34, 119, 11, 123, 62, 64 with the read-write head initially at the track 50 and the tracks are labelled form 0-199. The total number of disk seeks for SSTF scheduling algorithm is_____ **[NAT]**

Solution: *236*



21) Suppose a file F of size 16KB is shared by 100 processes, each process read the entire F 10 times sequentially, disk uses linked allocation policy to store both Inode and data of the file with block size 512byte in FAT and Block Pointer takes 4bytes. The number of disk block access related to access the file F in executing all the 100 processes is :
A. 33
B. 34
C. 35
D. 36

Solution: B)
As disk uses linked allocation for storing blocks, no extra blocks for FAT are needed. It needs to access Inode table from the disk and there are ceil [16KB/(512-4)] = 33 spanned block need to access to load the whole file F sequnetially . So total = 33+1 (Access the Inode) =34. Once the file loaded to memory by any one processs, we do not need to access hard disk block as the file F is shared by other 99 processes.

22) A Unix filesystem has 'A' KB blocks and B byte disk addresses. Each i-node contains 10 direct entries, one single indirect entry and one doubly indirect entry. Suppose half of all files are exactly 0.5A KB and other half of files are exactly 0.75A KB, what fraction of disk space would be wasted?
A. 62.5%
B. 25%
C. 37.5%
D. 50%

Solution: (C)
Both 0.5A KB and 0.75A KB file will use 'A' KB space. For each 0.5A KB file 0.5A KB is wasted; for each 0.75A KB file 0.25A KB is wasted; So total fraction wasted is (0.5A/A)*1/2 + (0.25A/A)*1/2 = 37.5%

23) Given that the disk has 200 tracks, with track 200 on the outside of the disk. The set of requests is 98, 183, 37, 122, 14, 124, 65, 67and the disk head starts at cylinder 53. The average seek length using the SCAN disk scheduling algorithm (moving outwards) is_____ **[NAT]**

Solution: 333
The sequence of disk movements (requests are serviced in this order) : 65 67 98 122 124 183 37 14.
The number of head movements : 12 + 2 + 31 + 242 + 59 + 180 + 23 = 333

24) Given that the disk has 200 tracks, with track 200 on the outside of the disk. The set of requests is 98, 183, 37, 122, 14, 124, 65, 67and the disk head starts at cylinder 53. The average seek length using the LOOK disk scheduling algorithm (moving outwards) is_____ **[NAT]**

Solution: 299
The sequence of disk movements (requests are serviced in this order) : 65 67 98 122 124 183 37 14.
The number of head movements : 12 + 2 + 31 + 242 + 59 + 146 + 23 = 299

25) Consider a disk queue with requests for cylinders 98, 183, 41, 122, 14, 124, 65, 67. The FCFS scheduling algorithm is used. The head is initially at cylinder number 53. The cylinders are numbered from 0 to 199. The total head movements or the seek operations (in number of cylinders) incurred while servicing these requests is _____.

Solution : Total number of seek operations = 632
Seek Sequence is : 98 183 41 122 14 124 65 67

26) Consider a disk queue with requests for cylinders 981, 183, 401, 122, 104, 324, 565, 267. The FCFS scheduling algorithm is used. The head is initially at cylinder number 553. The cylinders are numbered from 0 to 999. The total head movements or the seek operations (in number of cylinders) incurred while servicing these requests is _____.

Solution : Total number of seek operations = 2400
Seek Sequence is : 981 183 401 122 104 324 565 267

27) Consider a disk queue with requests for cylinders 55, 58, 39, 18, 90, 160, 150, 38, 184. The C-SCAN scheduling algorithm is used. The head is initially at cylinder number 100, moving towards last cylinder. The cylinders are numbered from 0 to 199. The average seek length is _____.

Solution :Total seek count is: 388
Sequence of operations' processing:
100,150,160,184,199,0,18,38,39,55,58,90

Avg Seek length = Total seek movements / Total requests = 388/9 = 43.11

28) Consider a disk queue with requests for cylinders 55, 58, 39, 18, 90, 160, 150, 38, 184. The SSTF scheduling algorithm is used. The head is initially at cylinder number 100, moving towards last cylinder. The cylinders are numbered from 0 to 199. The average seek length is _____.

Solution : Total seek count is: 248
Sequence of operations' processing:
100,90,58,55,39,38, 18,150,160,184

Average seek length: Total seek movements / Total requests = 248/ 9 ≈ 27.55 cylinders.

29) Consider a disk queue with requests for cylinders 55, 58, 39, 18, 90, 160, 150, 38, 184. The FCFS scheduling algorithm is used. The head is initially at cylinder number 100, moving towards last cylinder. The cylinders are numbered from 0 to 199. The average seek length is _____.

Solution : Total head movements (seek): 45 + 3 + 19 + 21 + 72 + 70 + 10 + 112 + 146 = 498 cylinders.

Average seek length: Total seek movements / Total requests = 498 / 9 ≈ 55.33 cylinders.

30) Consider a disk queue with requests for cylinders 82,170,43,140,24,16,190. The LOOK scheduling algorithm is used. The head is initially at cylinder number 50. The cylinders are numbered from 0 to 199. The total head movements or the seek operations (in number of cylinders) incurred while servicing these requests is _____.

Solution:
Total seek count is: 314
Sequence of operations' processing:
50,82,140,170,190,43, 24,16

31) Consider a disk queue with requests for cylinders 98, 183, 41, 122, 14, 124, 65, 67. The CLOOK scheduling algorithm is used. The head is initially at cylinder number 53. The cylinders are numbered from 0 to 199. The total head movements or the seek operations (in number of cylinders) incurred while servicing these requests is _____.

Solution:
Total seek count is: 326
Sequence of operations' processing:
53,65,67,98,122,124,183,14,41

32) Suppose the following disk request sequence (track numbers) for a disk with 100 tracks is given: 45, 20, 90, 10, 50, 60, 80, 25, 70. Assume that the initial position of the R/W head is on

track 50. The distance that will be traversed by the R/W head when the Shortest Seek Time First (SSTF) algorithm and the SCAN (Elevator) algorithm (assuming that SCAN algorithm moves towards 100 when it starts execution) is _____ and _____, respectively.

Solution :
SSTF: Total seek count is: 130
Sequence of operations' processing:
50,50,45,60,70,80, 90,25,20,10

SCAN: Total seek count is: 140
Sequence of operations' processing:
50,50,45,25,20,10, 0,60,70,80,90

33) Consider a file system with 1MB block size. Assume an inode of a file holds pointers to D direct data blocks, and a pointer to a single indirect block. Further, assume that the single indirect block can hold pointers to I other data blocks. What is the maximum file size that can be supported by such an inode design?

Solution : The total number of data blocks that can be addressed by the inode is calculated as follows:

Direct data blocks: D

Single indirect block can hold pointers to I data blocks

Total number of blocks addressed by the inode = D + I

Each block is 1MB in size. Therefore, the maximum file size supported by the inode design is given by the total number of blocks addressed by the inode multiplied by the block size.

Maximum file size = (D + I) * Block size

Make sure to convert all the units to the same before performing the calculation. For example, if D is given in number of blocks and I is given in number of pointers, you need to multiply them by the block size to get the size in bytes.

If D is given in number of blocks and I is given in number of pointers, then the maximum file size would be (D+I)×(1 MB)

34) Consider a FAT file system where disk is divided into B byte blocks, and every FAT entry can store an N bit block number. What is the maximum size of a disk partition that can be managed by such a FAT design?

Solution :The total number of blocks that can be addressed by the FAT entries is determined by the number of unique block numbers that can be represented using N bits. This can be

calculated using the formula:

Total number of blocks=2^N
Once we have the total number of blocks that can be addressed, we can calculate the maximum size of the disk partition by multiplying the total number of blocks by the block size:
Maximum size of disk partition=Total number of blocks×B = 2^N * B.