GATE

Computer Science & Information Technology

Computer Organization & Architecture

DPP 01

Disk

Q1 Consider a disk with 1000 sectors per track. Disk rotates with 6000 rpm. Seek time is 10ms. The disk access time is _____ milliseconds?

Q2 The transfer time T of the disk is
Where:
b = number of bytes to be transferred
N = Number of bytes on a track
r = rotation speed in rotations per seconds
(A) $\frac{2b}{rN}$ (B) $\frac{rb}{N}$
(C) $\frac{rN}{b}$ (D) $\frac{b}{rN}$

Q3 The total average read or write time on disk Ttotal is?
(A) $T_S + \frac{1}{2r} + \frac{b}{N}$ (B) $T_S + \frac{1}{2r} + \frac{b}{rN}$
(C) $T_S + 2r + \frac{b}{rN}$ (D) $\frac{T_S}{rN} + \frac{b}{N}$

Q4 Consider a disk with an average seek time of 4 ms, rotational delay of 2 ms, rotation speed of 15000 r.p.m. and 512-byte sectors with 500 sectors per track. A file occupies all of the sectors on 5 adjacent tracks. After reading the first track, if remaining tracks can be read with no seek time, then the time required in sequential organization to transfer the file will be nearly?
(A) 0.01 seconds (B) 0.034 seconds
(C) 0.34 seconds (D) 3.4 seconds

Q5 Consider a hard disk with 36 recording surfaces (0-35) having 10000 cylinders (0-9999) and each track contains 64 sectors (0-63). Data in disk are organized cylinder-wise and the addressing format is <cylinder no., surface no., sector no.>. A file in the disk is stored starting from address <1660, 28, 38> on 55788 sectors in contiguous manner. The address in format <c, h, s> for the last sector of the file is?
(A) <1685, 0, 17>
(B) <1685, 17, 0>
(C) <1686, 16, 0>
(D) <1686, 0 16>

Q6 Consider a memory hierarchy with 2-levels of cache. The L1-cache has 80% hit rate with 5ns access time. The L2-cache has 90% hit rate with 40ns of access time. The main memory has access time of 200 ns. The average memory access time is _____ns?

Q7 A multilevel cache system has access probability of L1 cache, L2 cache and main memory are 0.95, 0.042 and 0.008 respectively. The L1 cache, L2 cache and main memory have access time 10ns, 100ns and 1000ns respectively. The average memory access time of the memory hierarchy is _____ns?

Q8 Consider a fully associative cache of size 32Kbytes. The cache uses x bytes block. Consider the main memory address is of 20 bits. The tag in main memory address is of 13 bits the value of x is _____bytes?

Q9 Consider a disk with an average seek time of 5 ms, rotation speed of 12000 r.p.m. and 1Kbytes sectors with 1000 sectors per track. A file occupies 520 sequential sectors on a track. The time required in sequential organization to

transfer the file will be nearly _____ milliseconds?

Q10 Consider a disk with an average seek time of 10 ms, rotation speed of 10000 r.p.m. and 1Kbyte sectors with 100 sectors per track. Disk has 6 platers, each with two recording surface. A file of size 2650Kbytes is stored sequentially cylinder wise in the disk. The time required in sequential organization to transfer the file will be nearly _____ milliseconds?

GATE

Answer Key

Q1	15.01~15.01	Q6	17
Q2	(D)	Q7	23
Q3	(B)	Q8	128
Q4	(B)	Q9	10.1~10.1
Q5	(A)	Q10	270~270

Hints & Solutions

Q1 Text Solution:

6000 rotation time = 1 minute = 60 seconds = 60 × 1000 milliseconds,

1 rotation time = (60 × 1000)/6000 = 10 milliseconds

Disk access time = seek time + rotational latency + 1 sector transfer time

= 10 + (10/2) + (10/1000)

= 15.01ms

Q2 Text Solution:

For r rotations time taken = 1 second

For 1 rotation, time taken = 1/r seconds

In one rotation time (1/r), entire track can be transferred.

For N bytes transfer, time taken = 1/r

For b bytes transfer, time taken = b/rN

Q3 Text Solution:

For r rotations time taken = 1 second

For 1 rotation, time taken = 1/r seconds

Rotational latency = 1 rotation time / 2 = 1/2r

In one rotation time (1/r), entire track can be transferred.

For N bytes transfer, time taken = 1/r

For b bytes transfer, time taken = b/rN

total = seek time + rotational latency + 1 sector transfer time

= Ts + 1/2r + b/rN

Q4 Text Solution:

1 rotation time = $\frac{60000}{15000}$ = 4milliseconds

The file is stored on 5 tracks, which means 5 × 500 = 2500 sectors to be transferred.

Given that seek time is needed only once, but rotational latency will be needed for each track, which means 5 times.

So total file transfer time = seek time + 5 × 1 rotational latency + 5000 × 1 sector transfer time

= 4 + 5 × $\left(\frac{4}{2}\right)$ + 5000 × $\left(\frac{4}{500}\right)$ milliseconds

= 4 + 10 + 20 milliseconds

= 34 milliseconds

= 0.034 seconds

Q5 Text Solution:

Number of sectors per track (nt) = 64

Number of sectors per cylinder (nc) = 64 × 36 = 2304

Given address is in format of < cylinder no., surface no., sector no > = <c,h,s>

For the address <1660, 28, 38>

Sector number of the first sector of the file = (c × nc) + (h × nt) + s

= (1660 × 2304) + (28 × 64) + 38

= 3826470

Last sector number of the file = 3826470 + 55788 – 1 = 3882257

c = 3882257 / 2304 = 1685

h = (3882257 % 2304) / 64 = 0

s = (3882257 % 2304) % 64 = 17

Q6 Text Solution:

Average Memory Access Time = 5 + 0.2(40+ 0.1*200)

= 5 + 12

= 17 ns

Q7 Text Solution:

Average Memory Access Time = 0.95 * 10 + 0.042 * (10+100) + 0.008 * (10+100+1000)

= 9.5 + 4.62 + 8.88

= 23

Q8 Text Solution:

The 20 bits main memory address is divided into 2 parts in fully associative mapping:

Tag	Byte
13	

Hence number of bits remaining for byte offset = 20 – 13 = 7 bits.

For 7 bits, block size = 2^7 = 128 bytes

Q9 **Text Solution:**

1 rotation time = $\frac{60000}{12000}$ = 5milliseconds

Total file transfer time

= seek time + average rotational latency + 520 × 1 sector transfer time

= 5 + (5/2) + 520*(5/1000) milliseconds

= 10.1 milliseconds

Q10 **Text Solution:**

1 rotation time = $\frac{60000}{10000}$ = 6milliseconds

Number of surfaces in disk = 6 × 2 = 12

Number of sectors per cylinder = 12 × 100 = 1200

File size = 2650 k Bytes = $\frac{2650\ \text{KB}}{1\ \text{KB}}$ = 2650 sectors

Number of cylinders needed to store entire file = $\text{floor}\left(\frac{2650}{1200}\right)$ = 3

Which means 3 times seek time will be needed.

1200+1200, total 2400 sectors will occupy 2 full cylinders,

Remaining 2650 – 2400 = 250 sectors will occupy 3 more surfaces in 3rd cylinder.

Hence total surfaces used for storing file = 12 × 2 + 3 = 27,

Which means 27 times rotational latency is needed.

File transfer time

= (3 × seek time) + (27 × average rotational latency) + 2650 × 1 sector transfer time

= (3 × 10) + (27 × 6/2) + 2650 × (6/100)

= 30 + 81 + 159

= 270 milliseconds