Computer Organization & Architecture

Magnetic Disk

DPP: 1

Q1 Consider a direct mapped cache of size 32 Kbytes. The cache uses 64 bytes block. Consider main memory address is of 20 bits. For the main memory address $(94347)_{10}$, the tag is $(\_\_\_\_)_{10}$?

Q2 Consider a 2-way set associative cache of size 256 Kbytes. The cache uses 32 bytes block. Consider the main memory address is of 20 bits. For the main memory address $(86147)_{10}$, the tag is $(\_\_\_\_)_{10}$?

Q3 Consider a fully associative cache of size 16Kbytes. The cache uses 128 bytes block. Consider main memory address is of 20 bits. For the main memory address $(5182)_{10}$, the tag is $(\_\_\_\_)_{10}$?

Q4 A 2-way set associative cache with LRU cache replacement contains 8 blocks. The CPU requests for main memory blocks in following sequence:

8, 12, 0, 1, 5, 8, 1, 12, 8, 0, 1, 3, 6, 7, 3, 11, 2, 3, 6, 2, 8, 7, 11

Number of cold, capacity and conflict misses respectively are?

(A) 10, 3, 2 (B) 10, 2, 3

(C) 9, 3, 2 (D) 9, 2, 3

Q5 Consider a disk with 1000 sectors per track. Disk rotates with 6000 rpm. Seek time is 10ms. The disk access time is _____ milliseconds?

Q6 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) $\frac{b}{rN}$

Q7 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) $\frac{T_S}{rN} + \frac{b}{N}$

Q8 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

Q9 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>

Answer Key

Q1	2~2
Q2	1~1
Q3	40~40
Q4	(B)
Q5	15.01~15.01
Q6	(D)
Q7	(B)
Q8	(B)
Q9	(A)

Hints & Solutions

Q1 Text Solution:

Number of blocks in cache = $\frac{32\ \text{kB}}{64\ \text{B}} = 512$

Main memory block number = floor $\left(\frac{94347}{64}\right) = 1474$

Tag in main memory address = $\frac{1474}{512} = 2$

Q2 Text Solution:

Number of blocks in cache = $\frac{256\ \text{kB}}{32\ \text{B}} = 8\text{k} = 8192$

Number of sets in cache = $\frac{8192}{4} = 2048$

Main memory block number = $\frac{86147}{32} = 2692$

Tag = Main memory block number / number of sets in cache = $\frac{2692}{2048} = 1$

Q3 Text Solution:

Main memory block number = $\frac{5182}{128}$

In fully associative mapping, the main memory block number is tag only. Hence tag is 40.

Q4 Text Solution:

Number of sets in cache = $\frac{8}{2} = 4$

In set associative mapping, cache memory set number = main memory block number % 4

For the references of the given blocks, the miss and replacements are as follows:

Main memory block number	**Cache set number**	**Type of miss or hit**	**Replaced block**
8	8%4 = 0	Cold Miss	None
12	12%4 = 0	Cold Miss	None
0	0%4 = 0	Cold Miss	Replace 8
1	1%4 = 1	Cold Miss	None
5	5%4 = 1	Cold Miss	None
8	8%4 = 0	Conflict Miss	Replace 12
1	1%4 = 1	Hit	None
12	12%4 = 0	Conflict Miss	Replace 0
8	8%4 = 0	Hit	None
0	0%4 = 0	Conflict Miss	Replace 12
1	1%4 = 1	Hit	None
3	3%4 = 3	Cold Miss	None
6	6%4 = 2	Cold Miss	None
7	7%4 = 3	Cold Miss	None
3	3%4 = 3	Hit	None
11	11%4 = 3	Cold Miss	Replace 7
2	2%4 = 2	Cold Miss	None
3	3%4 = 3	Hit	None
6	6%4 = 2	Hit	None
2	2%4 = 2	Hit	None
8	8%4 = 0	Hit	None
7	7%4 = 3	Capacity Miss	Replace 11
11	11%4 = 3	Capacity Miss	Replace 3

Number of cold miss = 10

Number of capacity miss = 2

Number of conflict miss = 3

Q5 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

Q6 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

Q7 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

Q8 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

Q9 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