Computer Science & Information Technology

Computer Organization & Architecture

Cache Organization

DPP: 1

Q1 A cache is used to reduce the effective memory access time of 200ns without cache to 65ns with cache. If cache access time is 50ns, then cache hit rate is _____%?

Q2 A computer system has a cache with cache access time Tc = 10ns, hit ratio of 80% and average memory access time of Tm = 20ns. The access time for physical memory Tp is _____ ns?

Q3 A cache line has 128 bytes. The main memory has addressing latency 64ns and access bandwidth 1GB/s. The time required to fetch the entire cache line from the main memory is _____ ns?

Q4 Consider a system using a cache. The cache is having 70% hit ratio and is 9 times faster than main memory. The average memory access time then increased due to some program execution and the new average access time becomes 40% more than older one of 340ns. The hit ratio of new cache design is ____%?

Q5 Consider a memory hierarchy which takes 500 nanoseconds for access when there is a miss in cache and takes 100 nanoseconds for access when there is a hit in cache. Assume if among all memory references 90% of the references are having a hit on cache then average memory access time is _____ nanoseconds?

Q6 A system has a write through cache with access time of 100ns and hit ratio of 90%. The main memory access time is 1000ns. 70% of memory references are for read operations. Average memory access time for read-write operations both and effective hit rate(in %) are?

(A) 433, 90%
(B) 433, 63%
(C) 190, 90%
(D) 190, 63%

Q7 Consider a write through cache which can provide only 63.75% of effective hit rate. If among all memory references 75% references are for read, then the hit ratio of cache for only read operations ____%?

Q8 Consider a write through cache which can provide only 61.92% effective hit rate. If among all memory references 28% references are for write, then the hit ratio of cache for only read operations is _____?

Answer Key

Q1	90~90
Q2	60~60
Q3	192~192
Q4	53~53
Q5	140~140
Q6	(B)
Q7	85~85
Q8	86~86

Hints & Solutions

Q1 Text Solution:

Without cache memory access time = only main memory access time = 200ns

With cache, memory access time = average memory access time

$65 = H * 50 + (1–H) \times 200$

$H = 0.9$

$H = 90\%$

Q2 Text Solution:

Average memory access time = $0.8 * 10 + 0.2 * T_p$

$20 = 0.8 * 10 + 0.2 * T_p$

$T_p = 60ns$

Q3 Text Solution:

For 1 GB data, memory access time = 1 sec

For 128 bytes data, memory access time = (1sec * 128Bytes) / 1 GBytes

= 128 nanoseconds

The time required to fetch the entire cache line from the main memory is

= Latency time + block access time from memory

= 64 + 128

= 192 ns

Q4 Text Solution:

Main memory access time = 9 * cache memory access time

Old average memory access time = 340ns

$340 = 0.7 * Tcm + 0.3 * Tmm$

$340 = 0.7 * Tcm + 0.3 * 9 * Tcm$

$340 = 3.4 * Tcm$

$Tcm = 340/3.4 = 100ns$

Hence $Tmm = 9 * 100 = 900$ ns

New average memory access time = 1.4 * 340 = 476

$476 = H * 100 + (1-H) * 900$

$476 = 100 H + 900 – 900H$

$800 H = 424$

$H = 424 / 800 = 0.53 = 53\ \%$

Q5 Text Solution:

Here is information given about time required when there is hit and miss, hence general conceptual formula must be used. (Cache and main memory access times are not given explicitly)

Average memory access time = 0.9 * 100 + 0.1 * 500

= 90 + 50

= 140ns

Q6 Text Solution:

Average memory access time for read operations = 0.9 * 100 + 0.1 * 1000 = 90 + 100 = 190ns

Average memory access time for write operations = Main memory access time = 1000ns

Average memory access time for both = 0.7*190 + 0.3 * 1000 = 433 ns

Effective hit rate = Hit rate for read * % of read operations

= 0.9 * 0.7

= 0.63

= 63%

Q7 Text Solution:

Effective hit rate = Hit rate for read * % of read operations

0.6375 = Hit rate for read * 0.75

Hit rate for read = 0.6375 / 0.75 = 0.85 = 85%

Q8 Text Solution:

% of read operations = 100 – 28 = 72 %

Effective hit rate = Hit rate for read * % of read operations

0.6192 = Hit rate for read * 0.72
Hit rate for read = 0.86 = 86%