

Computer Organization & Architecture

DPP: 01

Cache Organization

- 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 $T_c = 10\text{ns}$, hit ratio of 80% and average memory access time of $T_m = 20\text{ns}$. The access time for physical memory T_p 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

$$200 = H * 50 + (1 - H) * 100$$

$$H = 0.9$$

$$H = 90\%$$

Q2 Text Solution:

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

$$20 = 0.8 * 10 + 0.2 * T_p$$

$$T_p = 60\text{ns}$$

Q3 Text Solution:

For 1 GB data, memory access time = 1 sec

For 128 bytes data, memory access time = $(1\text{sec} * 128\text{Bytes}) / 1\text{GBytes}$

$$= 128$$

nanoseconds

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

$$= \text{Latency}$$

time + block access time from memory

$$= 64 + 128$$

$$= 192\text{ ns}$$

Q4 Text Solution:

Main memory access time = $9 * \text{cache memory access time}$

Old average memory access time = 340ns

$$340 = 0.7 * T_{cm} +$$

$$0.3 * T_{mm}$$

$$340 = 0.7 * T_{cm} + 0.3$$

$$* 9 * T_{cm}$$

$$340 = 3.4 * T_{cm}$$

$$T_{cm} = 340 / 3.4 =$$

$$100\text{ns}$$

$$\text{Hence } T_{mm} = 9 * 100 = 900\text{ ns}$$

$$\text{New average memory access time} = 1.4 * 340 = 476$$

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

$$476 = 100 H + 900 - 900H$$

$$800 H = 424$$

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

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)

$$\text{Average memory access time} = 0.9 * 100 + 0.1 * 500$$

$$= 90 + 50$$

$$= 140\text{ns}$$

Q6 Text Solution:

Average memory access time for read operations = $0.9 * 100 + 0.1 * 1000 = 90 + 100 = 190\text{ns}$

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

$$\text{Average memory access time for both} = 0.7 * 190 + 0.3 * 1000 = 433\text{ ns}$$

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



$$0.6375 = \text{Hit rate for read} * 0.75$$

$$\text{Hit rate for read} = 0.6375 / 0.75 = 0.85 = 85\%$$

Q8 Text Solution:

$$\% \text{ of read operations} = 100 - 28 = 72 \%$$

$$\text{Effective hit rate} = \text{Hit rate for read} * \% \text{ of read operations}$$

$$0.6192 = \text{Hit rate for read} * 0.72$$

$$\text{Hit rate for read} = 0.86 = 86\%$$

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