Họ và tên: ………Trần Gia Nguyên Phong……………………. MSSV: …22002575……………………

**LAB 05: MEMORY HIERARCHY**

**Practice Problem 6.1**In the following, let *r* be the number of rows in a DRAM array, *c* the number of columns, *br* the number of bits needed to address the rows, and *bc* the number of bits needed to address the columns. For each of the following DRAMs, determine the power-of-two array dimensions that minimize max(*br*, *bc*), the maximum number of bits needed to address the rows or columns of the array.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Organization | *r* | *c* | *br* | *bc* | max(*br*, *bc*) |
| 16 x 1 | 4 | 4 | 2 | 2 | 2 |
| 16 x 4 | 4 | 4 | 2 | 2 | 2 |
| 128 x 8 | 8 | 16 | 3 | 4 | 4 |
| 512 x 4 | 32 | 16 | 5 | 4 | 5 |
| 1024 x 4 | 32 | 32 | 5 | 5 | 5 |

**Practice Problem 6.2**What is the capacity of a disk with two platters, 10,000 cylinders, an average of 400 sectors per track, and 512 bytes per sector?

10.000 cylinders = #track/surface

400 surface/track

512 bytes/sectors

2 platter

Capacity = (bytes/sectors) x (sectors/track) x (track/surface) x (surface/platter) x (platter/disk)

= 512 x 400 x 10000 x 2 x 2

= 8192000000

= 8.192 GB

**Practice Problem 6.3**Estimate the average time (in ms) to access a sector on the following disk:

Parameter Value  
Rotational rate 15,000 RPM  
*Tavg seek* 8 ms  
Average # sectors/track 500

T access = Track + T Rotation + T transfer = 8 ms

T Rotation = 1/2 x 1/rpm x 60s/1m x 1000ms/1s

= 1/2 x 1/15000 x 60/1 x 1000/1 = 60000/30000 = 2ms

T transfer = 1/rpm x 1/(sectors/track) x 60s/1m x 1000ms/1s

= 1/15000 x 1/500 x 60/1 x 1000/1 = 60000/7500000 = 0.8ms

T access = 8ms + 2ms + 0.008ms = 10.008ms =~ 10ms

**Practice Problem 6.4**Suppose that a 1 MB file consisting of 512-byte logical blocks is stored on a disk drive with the following characteristics:

Parameter Value

Rotational rate 10,000 RPM

*Tavg seek* 5 ms  
Average # sectors/track 1000  
Surfaces 4  
Sector size 512 bytes

For each case below, suppose that a program reads the logical blocks of the file sequentially, one after the other, and that the time to position the head over the first block is *Tavg seek + Tavg rotation.*

A. Best case: Estimate the optimal time (in ms) required to read the file given the best possible mapping of logical blocks to disk sectors (i.e., sequential).  
B. Random case: Estimate the time (in ms) required to read the file if blocks are mapped randomly to disk sectors.

**Practice Problem 6.6**As we have seen, a potential drawback of SSDs is that the underlying flash memory can wear out. For example, one major manufacturer guarantees 1 petabyte (1015 bytes) of random writes for their SSDs before they wear out. Given this assumption, estimate the lifetime (in years) of the SSD in Figure 6.16 for the following workloads:  
A. *Worst case for sequential writes:* The SSD is written to continuously at a rate of 170 MB/s (the average sequential write throughput of the device).  
B. *Worst case for random writes:* The SSD is written to continuously at a rate of 14 MB/s (the average random write throughput of the device).  
C. *Average case:* The SSD is written to at a rate of 20 GB/day (the average daily write rate assumed by some computer manufacturers in their mobile computer workload simulations).

**Practice Problem 6.7**Using the data from the years 2000 to 2010 in Figure 6.17(c), estimate the year when you will be able to buy a petabyte (1015 bytes) of rotating disk storage for $500. Assume constant dollars (no inflation).

