Họ và tên: ..... MSSV: .....

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, b_r the number of bits needed to address the rows, and b_c 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(b_r, b_c), the maximum number of bits needed to address the rows or columns of the array.

Organization	r	c	b_r	b_c	max(br, bc)
16 x 1					
16 x 4					
128 x 8					
512 x 4					
1024 x 4					

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?

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
$T_{avg\ seek}$	8 ms
Average # sectors/track	500

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
$T_{avg\ seek}$	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 $T_{avg\ seek} + T_{avg\ rotation}$.

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).

Metric	1980	1985	1990	1995	2000	2005	2010	2010:1980
$/MB	500	100	8	0.30	0.01	0.005	0.0003	1,600,000
Seek time (ms)	87	75	28	10	8	5	3	29
Typical size (MB)	1	10	160	1000	20,000	160,000	1,500,000	1,500,000

(c) Rotating disk trends