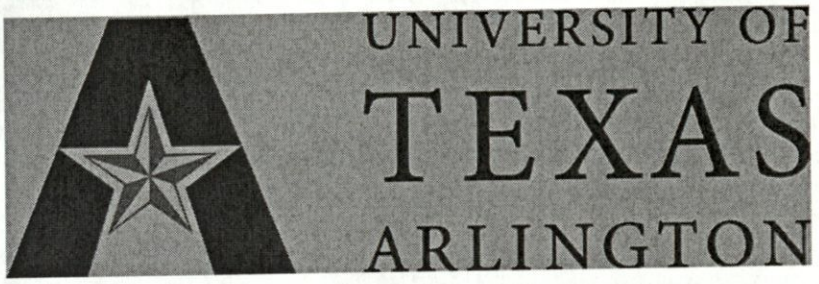

CSE 2312: Computer Organization & Assembly Language Programming Spring 2018

Homework #4

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Directions: Answer the questions on the following pages. Show all applicable steps for any problems requiring the use of formulas or calculations. Submit your completed assignment electronically as a single PDF document with this completed coversheet as the first page and your name written at the top of all additional pages. You may also submit the document in person before the deadline, in which case this coversheet must be completed and stapled to your solution pages.

1. **Compute the average read time for a *Seagate Barracuda ST750DM003* hard drive using the attached manufacturer product specification. Use the listed value for *average latency* in place of *average seek time* in your calculations, and a sector size of 512 bytes (the specification lists 4096 byte sectors, but these are emulated as 512 byte sectors to the OS). Also use the listed value for *average data rate* in place of *transfer rate*, and assume the 0.1ms of controller overhead.**

2. The table below represents an 8 block direct-mapped cache with write-through at some point during the execution of a program...

Index	V	Tag	Data
000	Y	01	Mem[01000]
001	N		
010	Y	10	Mem[10010]
011	N		
100	N		
101	N		
110	Y	11	Mem[11110]
111	Y	00	Mem[00111]

a) Show the modified table after the following sequence of cache accesses (listed by address): {0x19, 0x05, 0x07, 0x08, 0x14}. Assume that underlined accesses correspond to cache writes, while all others correspond to cache reads.

b) Which of the accesses from part 2a result in a cache read hit?

3. The table below represents the same scenario as part 2 using a write-back cache...

Index	V	Tag	Data	Dirty
000	Y	01	Mem[01000]	N
001	N			N
010	Y	10	Mem[10010]	N
011	N			N
100	N			N
101	N			N
110	Y	11	Mem[11110]	N
111	Y	00	Mem[00111]	N

a) Show the modified table after the following the following sequence of cache accesses (listed by address): {0x1F, 0x1D, 0x12, 0x1B, 0x1E}. Assume that underlined accesses correspond to cache writes, while all others correspond to cache reads.

b) Which of the accesses from part 3a result in a read hit?

c) Which of the accesses from part 3a will immediately change a value in memory?

2.0 Drive Specifications

Unless otherwise noted, all specifications are measured under ambient conditions, at 25°C, and nominal power. For convenience, the phrases *the drive* and *this drive* are used throughout this manual to indicate the following drive models:

ST3000DM001	ST2000DM001	ST1500DM003	ST1000DM003
ST750DM003	ST500DM002	ST320DM000	ST250DM000

2.1 Specification summary tables

The specifications listed in **Table 1** and **Table 2** are for quick reference. For details on specification measurement or definition, refer to the appropriate section of this manual.

Table 1 Drive specifications summary for 3TB, 2TB, 1.5TB, 1TB and 750GB models

Drive Specification*	**ST3000DM001; ST2000DM001**	**ST2000DM001; ST1500DM003**	**ST1000DM003; ST750DM003**
Formatted capacity (512 bytes/sector)**	3000GB (3TB); 2000GB (2TB)	2000GB (2TB); 1500GB (1.5TB)	1000GB (1TB); 750GB
Guaranteed sectors	5,860,533,168; 3,907,029,168	3,907,029,168; 2,930,277,168	1,953,525,168; 1,465,149,168
Heads	6	4	2
Disks	3	2	1
Bytes per sector (4K physical emulated at 512-byte sectors)	4096	4096	4096
Default sectors per track	63	63	63
Default read/write heads	16	16	16
Default cylinders	16,383	16,383	16,383
Recording density (max)	1807kFCI	1807kFCI	1807kFCI
Track density (avg)	352ktracks/in	352ktracks/in	352ktracks/in
Areal density (avg)	625Gb/in^2	625Gb/in^2	625Gb/in^2
Spindle speed	7200 RPM	7200 RPM	7200 RPM
Internal data transfer rate (max)	2147Mb/s	2147Mb/s	2147Mb/s
Average data rate, read/write (MB/s)	156MB/s	156MB/s	156MB/s
Maximum sustained data rate, OD read (MB/s)	210MB/s	210MB/s	210MB/s
I/O data-transfer rate (max)	600MB/s	600MB/s	600MB/s
Cache buffer	64MB	64MB	64MB
Height (max)	26.1mm / 1.028 in	26.1mm / 1.028 in	20.17mm / 0.7825 in
Width (max)	101.6mm /4.0 in (± 0.010 in)	101.6mm /4.0 in (± 0.010 in)	101.6mm / 4.0 in (± 0.010 in)
Length (max)	146.99mm / 5.787 in	146.99mm / 5.787 in	146.99mm / 5.787 in
Weight (typical)	626g /1.38 lb	535g / 1.18 lb	400g / 0.88 lb
Average latency	4.16ms	4.16ms	4.16ms
Power-on to ready (max)	<17.0s	<17.0s	<10.0s
Power-on to ready, 2.5A spin-up code option (typical)	<10.0s	<10.0s	n/a

(1.)

$$\frac{\text{Time}}{\text{Rotation}} = \frac{1 \text{ minute}}{7200 \text{ rotation}} \Big| \frac{60 \text{ seconds}}{1 \text{ minute}} = .00833 \text{ s/rotation}$$

$$= 8.33 \text{ ms/rotation}$$

Delay for one disk $= \frac{1}{2} \cdot 8.33 \text{ ms} = 4.167 \text{ ms}$ Average seek time

Strip unit = 4kB

Each sector = 512B

$$\frac{8 \text{ sectors}}{\text{strip unit}} \Big| \frac{\text{track}}{63 \text{ sectors}} \Big| \frac{8.33 \text{ ms}}{} = 1.05 \text{ ms}$$

1 strip unit = 8 sectors

63 sectors per track

Average read time = 4.16 ms + 4.3 ms + 1.05 ms = $\boxed{9.51 \text{ ms}}$

(2.) a)

Index	V	Tag	Data
000	N		
001	Y	00	Mem[00001]
010	Y	01	Mem[01010]
011	Y	10	Mem[10011]
100	Y	10	Mem[10100]
101	Y	01	Mem[01101]
110	Y	01	Mem[01110]
111	N		

b)

Address	10011	00001	00110	01010	01110	11001
	Miss	Hit	Hit	Miss	Miss	Miss

00001	11100	10100
Miss	Miss	Miss

(3.) a)

Index	V	Tag	Address	Data
000	Y	01	00001	01000
100	Y	11	11011	11110
111	Y	00	11100	00111

Index	V	Tag	Address	Data
001	N		001	
011	N		011	

b) Accesses for part 3a that resulted in a read hit.

Index 001

c) Index 111 is immediate change in value.