

CS 473
Final Exam
May 5, 2003

The following exam is open book and open notes. You may feel free to use whatever additional reference material you wish, but **no electronic aids** are allowed. Please note the following instructions. There will be a ten point deduction for failure to comply with them:

- start each problem on a new sheet of paper
- write your social security number, but not your name, on each sheet of paper you turn in
- show your work whenever appropriate. There can be no partial credit unless I see how answers were arrived
- be succinct. You may lose points for facts that, while true, are not relevant to the question at hand

You have until 10:00 to finish the exam.

1. (20 points) Floating point:

- (a) Convert the human-readable decimal number 62.375 to IEEE floating point format.
- (b) Add it to the IEEE floating point number 0xc1ab0000. Your final result should be a 32 bit (8 digit) hexadecimal number.

2. (10 points) Consider the following sequence of MIPS instructions.

```
add $1, $2, $3
lw  $2, 100($1)
add $3, $1, $2
```

- (a) Draw arrows showing the dependencies in this code.
 - (b) Draw a Gantt (timing) chart showing how this code would be executed using the MIPS pipeline on page 492 of the text. Use arrows showing forwarding; be sure to show the forwarding in the correct pipeline stages.
3. (10 points) Draw a Gantt (timing) chart to show how the following code would be executed on a CDC 6600. Use arrows to show forwarding.

```
X1 <- X2 * X3
X4 <- X6 * X1
X6 <- X5 + X0
```

4. (15 points) Here is some information from the memory of a computer using Intel's virtual memory scheme:

Address	Contents
25204b40	6366a404
2bd6a4d4	235c9800
4fdd349c	2bd6a043
57c47d60	2520407f
736445a8	57c47067
73644674	4fdd3007

Assume the PDBR contains 73644000.

- (a) What will happen if a process running in user mode attempts to write to virtual address 675274d4?
- (b) How is it possible for a page table entry to have a Dirty bit equal to 1, but an Accessed bit equal to 0?

5. (10 points)

- (a) What is the largest that an 8-way set-associative cache can be and still let a system using Intel's virtual memory scheme do a simultaneous lookup in TLB and (physically addressed) cache?
- (b) Suppose the largest possible cache from part 5a uses a 256 byte block size. How is the address broken up into tag, index, and offset? Suppose an attempt is made to look up address 0x13a48df8 in this cache. What will the tag, index, and offset be for this address?
- (c) That's a pretty big block size (in part 5b). What are the drawbacks to such a big block size?

6. (15 points) Calculate the parity and check bits for the eight-bit binary number 01100100. Express your result as a 13 bit binary number with the bits in the order M8 M7 M6 M5 C8 M4 M3 M2 C4 M1 C2 C1 P.

7. (20 points) A particular computer system, and its associated disk drive, has the following characteristics:

Processor speed:	2 billion instructions/sec
Average disk seek time:	10 msec
One-track seek time:	1 msec
Rotation speed:	6000 RPM
Data transfer speed:	100,000,000 bytes/sec

This computer system is executing a program that requires it to repeatedly execute transactions requiring the following sequence of operations:

- Spend 100,000 instructions calculating its next sequence of reads and writes.
 - Read 5 blocks from the disk. The first block is at a random location on the disk; the remaining 4 are all on adjacent tracks. Amazingly, they are offset from one another just right so the only time required to get from one block to the next is the track-to-track seek time. Each block is 10,000 bytes.
 - Spend 10 million instructions processing the data.
 - Write one (10,000 byte) block to a random location on disk.
- (a) How long does it take to perform one of these transactions?
 - (b) You are given the option of doubling the performance of one of the following aspects of the system: the processor speed, the speed the head can move between tracks (so the seek time would be halved), or the disk transfer rate. Which one should you pick? Why, in the practical world, is that the hardest one of the three to improve?