CS 473
Midterm Exam
October 16, 2002

The following exam is open book and open notes. You may feel free to use whatever additional reference material you wish, but **no calculators** 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 10:30 to finish the exam.

1. *(30 points)* Convert the following number from human-readable decimal to IEEE format: -12.375 (express your result in hexadecimal). Use the floating point addition algorithm to add it to the IEEE floating point number `0x40200000` (once again, express your result in hexadecimal). Convert your final result to human-readable decimal.

2. *(20 points)* Consider the following MIPS code fragment:

```
lw   $1, 100($4)
addi $2, $1, 12
add  $4, $3, 2
sub  $2, $3, $4
```

   (a) Draw arrows showing the dependencies in the code.

   (b) Draw dashed arrows showing the antidependencies.

   (c) Draw a Gantt (timing) chart showing the execution of this code, assuming all possible forwarding and assuming loads stall instead of using a delayed load. Use arrows to show forwarding between the instructions.

   (d) Reorder the code so that it can run as fast as possible.

3. *(30 points)* The book has a possible superscalar version of the MIPS on page 512. I've copied this figure on the last page of this exam, for use in problem 3a

   (a) In the figure as given, the top pipeline takes just as long to execute as the bottom pipeline. How could the top pipeline be modified to execute in only four cycles, instead of five?

   (b) After making the modification described in part 3a, suppose the following two instructions are in the pipelines (so the first instruction is in the top pipe, and the second is in the bottom):

```
ori  $1, $2, 0x100
lw   $1, 100($2)
```

   What will happen to register $1?

   (c) Now suppose the following two pairs of instructions are in the pipeline:

```
add  $3, $4, $5
lw   $1, 100($2)
ori  $1, $2, 0x100
sw   $6, 100($7)
```

   Describe the hazard that is created. How can it be resolved?

4. *(20 points)* Draw a Gantt chart showing the execution of the following code on a CDC6600:

```
X7 <- X1/X7
X1 <- X2*X3
X4 <- X5*X6
X1 <- X1+X4
X4 <- X1*X7
```