

Name (LAST, First — please PRINT): \_\_\_\_\_

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**CMPE110 - Computer Architecture (Fall 2002)**  
**Midterm exam**

November 4, 2002

No books, notes or calculator.  
Simple computations are expected to be carried out by hand.  
Use the back of pages as scratch paper, if necessary.

| Exercise   | Score | Out of |
|------------|-------|--------|
| M.1        |       | 12     |
| M.2        |       | 10     |
| M.3        |       | 10     |
| M.4        |       | 8      |
| M.5        |       | 14     |
| <b>TOT</b> |       | 54     |

**Ex M.1** (8 points) A machine has a 500 MHz clock and the following characteristics:

|              |     |     |                |     |     |
|--------------|-----|-----|----------------|-----|-----|
| Instr. Class | A   | B   | C              | D   | E   |
| CPI          | 1   | 2   | $\text{CPI}_C$ | 5   | 5   |
| Frequency    | 30% | 10% | 30%            | 20% | 10% |

What is the maximum *integer* value of  $\text{CPI}_C$  to have a **native** MIPS rating of *at least* 200?  
(Justify your answer — no credit will be given for a correct answer if work is not shown)

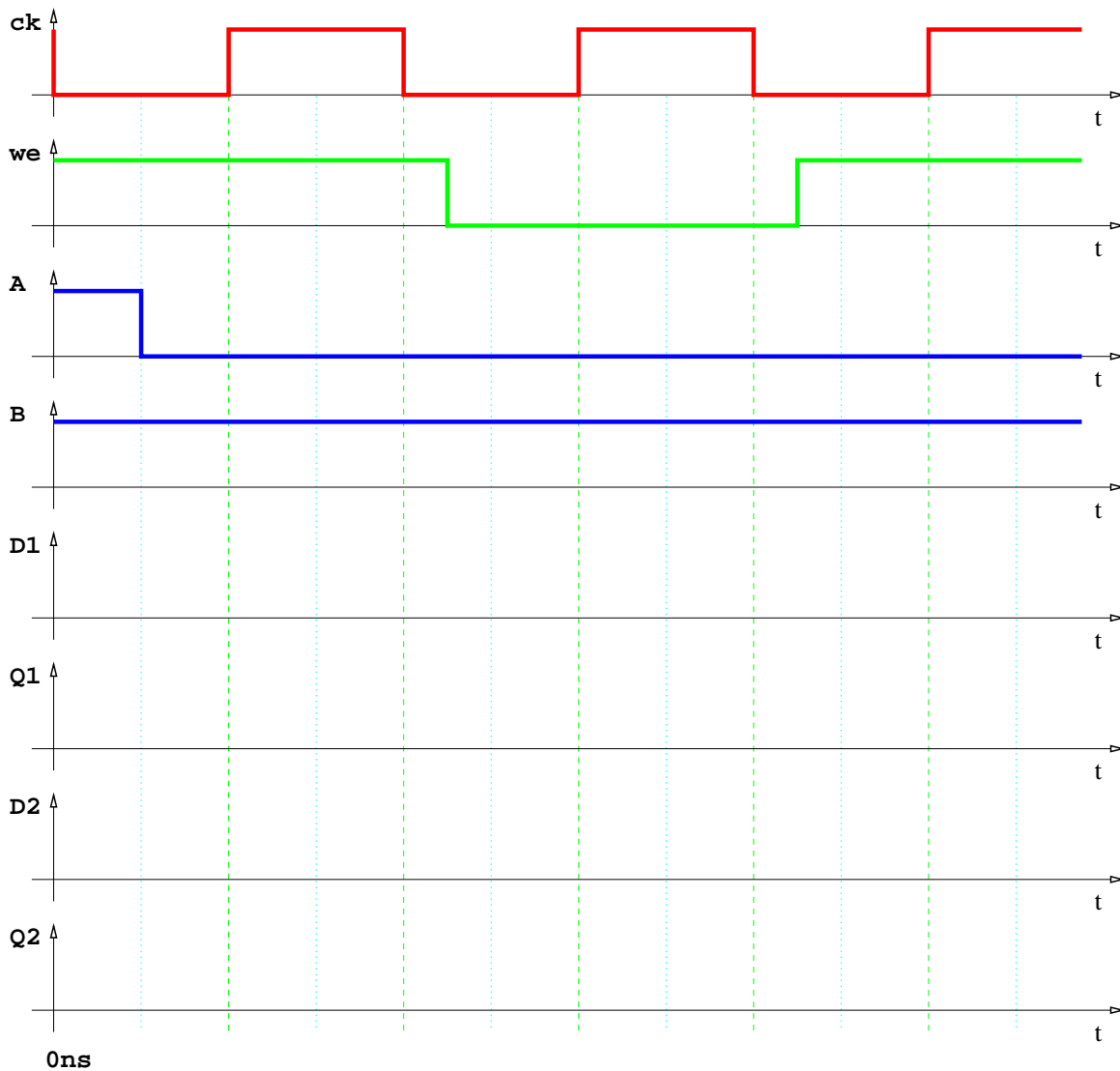
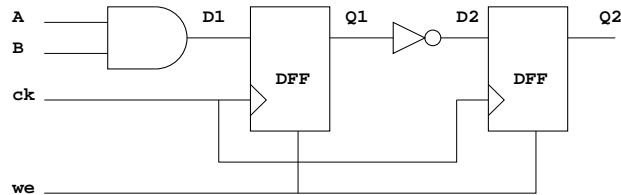
(4 points) Instructions in class E are floating-point instructions. What is the MFLOP rating?

**Ex M.2** (10 points) Using Radix-4 Booth's algorithm, perform the multiplication  $A \times B$  (where  $A$  is the multiplicand and  $B$  is the multiplier).  $A$  and  $B$  are the two's complement binary numbers  $A = 00101$  and  $B = 11010$ . If you don't remember Radix-4, for half credit you can use Radix-2 (but don't do both!).

I am using (circle one):    Radix-4 (full credit)            Radix-2 (half credit)

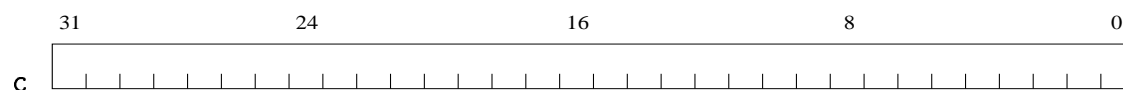
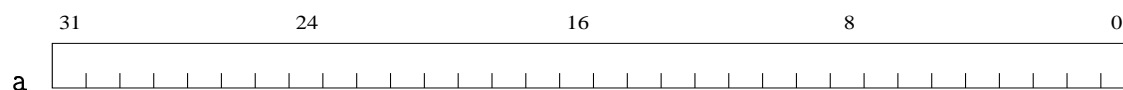
**Ex M.3** (10 points) Complete the timing diagram below (for D1, Q1, D2, and Q2) clearly indicating the time of every transition. Assume that the values of A, B, and we have been the same as the ones shown for  $t = 0$  for all  $t < 0$ .

Propagation delay times are  $t_{pd}(\text{AND}) = 1 \text{ ns}$ ,  $t_{pd}(\text{NOT}) = 2 \text{ ns}$ ,  $t_{pd}(\text{FF}) = 1 \text{ ns}$ . The frequency of the clock signal ck is 125 MHz.



**Ex M.4** (8 points) The type `float` conforms to the IEEE-754 single precision definition. Show the binary representation of variables `a` and `c` at the end of the execution of the following piece of code.

```
float    a, b, c;  
    a = 25.5;  
    b = a - a;  
    c = a / b;
```



**Ex M.5** (10 points) This is a piece of MIPS binary code, with the instructions' addresses on the left. Disassemble the program, that is, reconstruct the original assembly code using the information given in the next page.

|            |                                  |
|------------|----------------------------------|
| 0x0000A000 | 0010000000000101000000000001010  |
| 0x0000A004 | 00100000101001011111111111111110 |
| 0x0000A008 | 00000000101000000001100000101010 |
| 0x0000A00C | 00010000011000001111111111111101 |
| 0x0000A010 | 00000000101001010011100000100000 |

(4 points) What are the values in register 3, and 7 at the end of execution (in decimal)?

\$3 =                      \$7

| MIPS INSTRUCTIONS |        |          |
|-------------------|--------|----------|
| Instruction       | Opcode | Function |
| add               | 0x00   | 0x20     |
| addi              | 0x08   | n.a.     |
| and               | 0x00   | 0x24     |
| andi              | 0x0C   | n.a.     |
| or                | 0x00   | 0x25     |
| ori               | 0x0D   | n.a.     |
| sub               | 0x00   | 0x22     |
| slt               | 0x00   | 0x2A     |
| beq               | 0x04   | n.a.     |
| j                 | 0x02   | n.a.     |
| lw                | 0x23   | n.a.     |
| sw                | 0x2B   | n.a.     |