

CS 273
Final Exam
May 10, 2004

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 12:30 to finish the exam. The questions are equally weighted.

1. Arithmetic

- (a) Convert the following number from decimal to eight bit 2's complement binary: 83
- (b) Convert the following number from eight bit 2's complement hexadecimal to decimal: f9
- (c) Perform the following 8 bit hexadecimal operations. Give both the result, and the condition codes which would result from executing these operations on an HCLL.

$$\begin{array}{r} (1) \quad 13 \\ + \quad f7 \\ \hline \end{array} \qquad \begin{array}{r} (2) \quad a3 \\ - \quad 43 \\ \hline \end{array}$$

- (d) Perform the following 4×4 bit binary multiplication, giving an eight bit result.

$$\begin{array}{r} 0011 \\ \times 1101 \\ \hline \end{array}$$

- (e) Perform the following 4×4 bit binary division, giving the quotient and remainder

$$0011 \overline{) 1101}$$

2. Assemble the following assembly code into machine code.

```
RAM    equ    0
EEPROM equ    $f800
OFF    equ    3
mask   equ    $80
        org    RAM
v1     rmb    1
v2     rmb    1
        org    EEPROM
start  ldaa   v2
        adda  OFF,x
        jmp   bogus
        brclr OFF,y mask start
bogus  ldaa   #start
        bcc   start
```

3. Consider the following HC11 machine code.

```
0004 f800 18 df 06
0005 f803 7c 00 07
0006 f806 d6 07
0007 f808 d7 02
0008 f80a 18 ce 00 04
0009 f80e cd ee 02
0010 f811 1e 01 02 02
0011 f815 20 03
0012 f817 08
0013 f818 20 02
0014 f81a 18 09
0015 f81c 20 fe
```

- (a) Disassemble the code. You can leave the operands as hexadecimal “magic constants” (but you do need to have the correct addressing mode notation).
- (b) Suppose the code is executed. Before we begin, assume the program counter contains \$f800, and all the other registers contain 0. After it is executed, what is the contents of the A, B, X, Y, PC, and CCR registers? You need only consider the NZVC bits of the CCR. Be sure to explain what each of the instructions does, so it’ll be possible to give partial credit.
4. Compile the following into HC11 assembly code. Be sure to set up the procedure to perform a proper callee-save activation record. Variables `j` and `k` are global variables; the main program consists of the `j = bogus(3);` line.

```
j = bogus(3);
int bogus(int k)
{
    int l;
    l = 0;
    for (i = 0; i < k; i++)
        l = l + i;
    return l;
}
```

5. A “servomechanism” (normally just called a servo) is a motor with a variable resistor attached so you can read the motor’s position. The servo controller gives the motor’s desired location, and the motor moves until it reaches that location. Suppose you need to write the control software for a servo. The variable resistor is on A/D channel 0, and the control is on motor channel 1. Turning the motor on in direction 0 will move the motor in the direction that increases the value in the A/D channel, while moving it in direction 1 will move it in the direction that decreases the value. You will receive servo commands in the form of changes to the contents of A/D channel 1.

Write the main control loop for a servo in HC11 assembly code. Your code should continually sample A/D channel 1 and A/D channel 0, and give motor control commands which will adjust the motor position to adjust A/D channel 0 to match channel 1.

You can assume that the A/D has been properly set up, and you don’t need to worry about any other motors than the one you are controlling.

One last question: in your estimation, what fraction of the project did you do, and what fraction did your partner(s) do? Yes, I do want this on a separate piece of paper from any of the answers to your exam questions; this won’t affect your grade on this exam, but may affect the credit the partners receive on the project parts.