Problem 1: Determine the format for each instruction and the decimal values of each instruction field for the following program segment:

```
addi  $s3, $zero, 396
Loop: lw    $t0, 256($s3)
       add    $t0, $s2, $t0
       sw     $t0, 256($s3)
       addi   $s3, $s3, -4
       bne    $s3, $zero, Loop
```

Give also the machine code instructions (32 bits per instruction) for that program segment. See Appendix A.10 of the textbook for op-codes of operands. Use 2’s complement to represent negative numbers.

Problem 2: The following code fragment processes two arrays and produces an important value in register $v0. Assume that each array consists of 2500 words indexed 0 through 2499, that the base addresses of the arrays are stored in $a0 and $a1, respectively, and their sizes (2500) are stored in $a2 and $a3, respectively. Add comments to the code and describe in one sentence what this code does. Specifically, what will be returned in $v0?

```
sll $a2, $a2, 2
sll $a3, $a3, 2
add $v0, $zero, $zero
add $t0, $zero, $zero
outer:  add $t4, $a0, $t0
        lw    $t4, 0($t4)
        add $t1, $zero, $zero
inner:  add $t3, $a1, $t1
        lw    $t3, 0($t3)
        bne   $t3, $t4, skip
        addi $v0, $v0, 1
skip:   addi $t1, $t1, 4
        bne   $t1, $a3, inner
        addi $t0, $t0, 4
        bne   $t0, $a2, outer
```

Problem 3

Assume that the code from Problem 2 is run on a machine with a 2 Ghz clock that requires the following number of cycles for each instruction:

<table>
<thead>
<tr>
<th>Instruction</th>
<th>Cycles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Add, addi, sll</td>
<td>1</td>
</tr>
<tr>
<td>Lw, bne</td>
<td>2</td>
</tr>
</tbody>
</table>

In the worst case, how many seconds will it take to execute this code?
Problem 4
Convert the following C code to MIPS assembly:

for (i=0, i<=100; i++)

a[i] = b[i] + c;

where a and b are arrays of words with their base addresses in $a0 and $a1, respectively. Register $t0 is associated with variable i and register $s1 is associated with variable c.

Problem 5
What decimal number does the following signed 2’s complement binary number represent:

a. 1111 1111 1111 1111 1111 1111 0000 0110
b. 1111 1111 1111 1111 1111 1111 1110 1111
c. 0111 1111 1111 1111 1111 1111 0010 0110

Problem 7
Perform the following operations with $X = 1111 1111 1111 1111 1111 1111 0000 0110$ and $Y = 0000 0000 0000 1111 1111 1111 0000 0010$, where X and Y are in signed 2’s complement form.

a. $X + Y$
b. $X - Y$

Due: 9/20/2006