Problem 1 (25 Points)
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 (25 Points)
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 (25 Points):
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 it will take to execute this code?

Problem 4 (25 Points)
Convert the following C code to MIPS assembly:

```c
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 $c$.

Due: 9/12/2008