CMPE12c Homework #4  Spring 2003
Use the MAL/TAL sheets passed out during the exam

1) (15 pts) Write a MAL code procedure that calculates the factorial of the number passed in $a0. The return value should be in $v0. Use recursion and use the system stack to store the return address. For example, if 5 is in $a0 then return 5x4x3x2x1= 120 in $v0.

2) (10 pts) Hand assemble the following MAL code. Start instructions at address 0x0004 4800.

```assembly
and    $4, $5, $8
beq    $4, $0, bob
lui    $20, 0x66aa

bob:
    lb     $9, -8($20)
```

3) (15 pts) Hand assemble the following MAL .text section. Start instructions at address 0x0008 8800 and data starts at 0x0004 4400. Show what the .data section would also look like.

```assembly
.data
value: .word 12

.text
loop:
    getc  $8  # convert to TAL
    syscall
    la     $9, value
    bltz   $9, $0, loop
    done   $9, $0, loop
    syscall
```

4) (5 pts) Disassemble the following MIPS RISC code. Make up label names when needed. The code starts at address 0x0040 0000.

<table>
<thead>
<tr>
<th>Address</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x0040 0000</td>
<td>0x41E6 0000</td>
</tr>
<tr>
<td>0x0040 0004</td>
<td>0x9287 1020</td>
</tr>
<tr>
<td>0x0040 0008</td>
<td>0x00AB A806</td>
</tr>
<tr>
<td>0x0040 000C</td>
<td>0x0681 fffd</td>
</tr>
</tbody>
</table>
5) (5 pts) Give a correct TAL translation of the virtual instruction
   \[ \text{la } \$15, \text{ variable} \]
   if “variable” has been assigned the address 0x0024 6088

6) (5 pts) How can the MAL “move” instruction be implemented in TAL?

7) (5 pts) Give two ways that the MAL instruction
   \[ \text{blt } \$3, \$18, \text{ branch} \]
   can be translated into TAL instructions.

8) (5 pts) What can an assembler do if a calculated branch offset is too large to fit into the offset field of an instruction?