

Name:

Id#

## COE 301/ICS 233, Term 161

### Computer Architecture & Assembly Language

#### Quiz# 3 Solution

Date: Tuesday, Nov. 22, 2016

**Q1.** A recursive procedure **TH(N)** returns  $1+2*\mathbf{TH}(N-1)$  for  $N > 1$ , 1 if  $N=1$ , and zero otherwise. This is called Tower of Hanoi. **TH(N)** is defined as follows:

```
int TH(int N) {
    if (N <= 0) return 0;
    else if (N=1) return 1;
    else return (1 + 2*TH(N-1));
}
```

Assume **TH** receives its argument  $N$  in register  $\$a0$  and return its results in  $\$v0$ . The above procedure is called from some Main program, which needs **not** to be implemented here. Write a minimal MIPS program for the above procedure.

```
TH:   slti   $t0, $a0, 1    # (n < 1)?
      beq   $t0, $0, next   # if false branch to next
      li   $v0, 0          # $v0 = 0
      jr   $ra             # return to caller
next: slti   $t0, $a0, 2    # (n < 2)?
      bne  $t0, $0, iterate # if false branch to iterate
      li   $v0, 1          # $v0 = 1
      jr   $ra             # return to caller

iterate: addiu $sp, $sp, -4  # allocate 1 word on stack
        sw   $ra, 0($sp)    # save return address
        addiu $a0, $a0, -1  # argument = n-1
        jal  TH             # call TH(n-1)
        sll  $v0, $v0, 1    # $v0 = 2*TH(n-1)
        addi $v0, $v0, 1    # return 1 + 2*TH(n-1)
        lw   $ra, 0($sp)    # restore return address
        addi $sp, $sp, 4    # free stack frame
        jr   $ra             # return to caller
```