Computer Architecture
Spring 2019
Homework No. 3

1.

Let f, g, and h are stored at $s0, $s1, $s2

```
addi $t0, $s2, -5
add $s0, $s1, $t0
```

2.

```
sub $t0, $s3, $s4
sll $t0, $t0, 2
add $t1, $s6, $t0
lw $t2, 0($t1)
sw $t2, 32($s7)
```

3.

- Memory address where Fact procedure is located

```
Fact:
200     addi    $sp, $sp, -8
204     sw      $ra, 4($sp)
208     sw      $a0, 0($sp)
212     slti    $t0, $a0, 1
216     beq     $t0, $zero, L1
220     addi    $v0, $zero, 1
224     addi    $sp, $sp, 8
228     jr      $ra
L1:
232     addi    $a0, $a0, -1
236     jal     fact
240     lw      $a0, 0($sp)
244     lw      $ra, 4($sp)
248     addi    $sp, $sp, 8
252     mul     $v0, $a0, $v0
256     jr      $ra
```

- Code execution

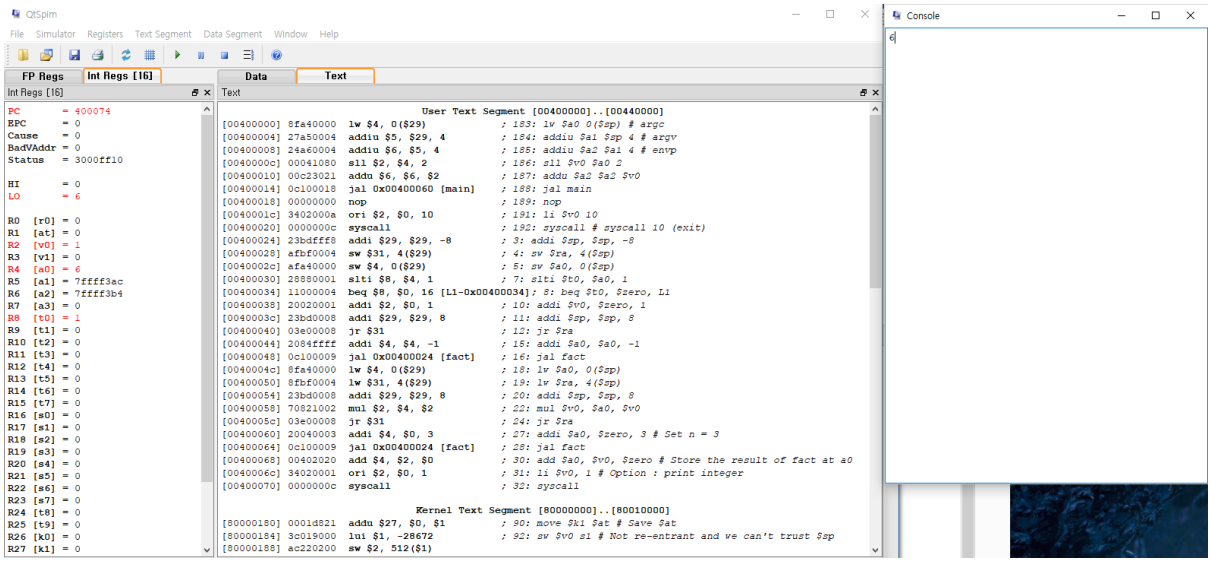
```
300     jal     Fact            # $ra = 304, $pc = 200, $sp = 500, $a0 = 3
200     addi    $sp, $sp, -8    # $sp = 492
204     sw      $ra, 4($sp)     # save M[496] = 304
208     sw      $a0, 0($sp)     # save M[492] = 3
212     slti    $t0, $a0, 1     # since 3 >= 1, $t0 = 0
216     beq     $t0, $zero, L1  # since $ t0 = 0, go to L1 : $pc = 232
232     addi    $a0, $a0, -1    # $a0 = 2
```

```
236     jal     Fact                # go to factorial $ra = 240, $pc = 200
200     addi    $sp, $sp, -8        # sp = 484
204     sw      $ra, 4($sp)         # save M[488] = 240
208     sw      $a0, 0($sp)         # save M[484] = 2
212     slti    $t0, $a0, 1         # since 2 >= 1, $t0 = 0
216     beq     $t0, $zero, L1      # since $ t0 = 0, go to L1 : $pc = 232
232     addi    $a0, $a0, -1        # $a0 = 1
236     jal     fact                # $ra = 240, $pc = 200
200     addi    $sp, $sp, -8        # sp = 476
204     sw      $ra, 4($sp)         # save M[480] = 240
208     sw      $a0, 0($sp)         # save M[476] = 1
212     slti    $t0, $a0, 1         # since 1 >= 1, $t0 = 0
216     beq     $t0, $zero, L1      # since $ t0 = 0, go to L1 : $pc = 232
232     addi    $a0, $a0, -1        # $a0 = 0
236     jal     fact                # go to factorial $ra = 240, $pc = 200
200     addi    $sp, $sp, -8        # sp = 468
204     sw      $ra, 4($sp)         # save M[472] = 240
208     sw      $a0, 0($sp)         # save M[468] = 0
212     slti    $t0, $a0, 1         # since 0 < 1, $t0 = 1
216     beq     $t0, $zero, L1      # since $ t0 = 1, does not go to L1
220     addi    $v0, $zero, 1       # $v0 = 1
224     addi    $sp, $sp, 8         # sp = 476
228     jr      $ra                 # $pc = 240
240     lw      $a0, 0($sp)         # $a0 = M[476] = 1
244     lw      $ra, 4($sp)         # $ra = M[480] = 240
248     addi    $sp, $sp, 8         # $sp = 484
252     mul     $v0, $a0, $v0       # $v0 = 1 * 1 = 1
256     jr      $ra                 # $pc = 240
240     lw      $a0, 0($sp)         # $a0 = M[484] = 2
244     lw      $ra, 4($sp)         # $ra = M[488] = 240
248     addi    $sp, $sp, 8         # $sp = 492
252     mul     $v0, $a0, $v0       # $v0 = 2 * 1 = 2
256     jr      $ra                 # go to 240
240     lw      $a0, 0($sp)         # $a0 = M[492] = 3
244     lw      $ra, 4($sp)         # $ra = M[496] = 304
248     addi    $sp, $sp, 8         # $sp = 500
252     mul     $v0, $a0, $v0       # $v0 = 3 * 2 = 6
256     jr      $ra                 # go to 304
```

- Assembly code

```
        .text
fact:
    addi $sp, $sp, -8
    sw   $ra, 4($sp)
    sw   $a0, 0($sp)

    slti $t0, $a0, 1
    beq  $t0, $zero, L1

    addi $v0, $zero, 1
    addi $sp, $sp, 8
    jr   $ra

L1:
    addi $a0, $a0, -1
    jal  fact

    lw   $a0, 0($sp)
    lw   $ra, 4($sp)
    addi $sp, $sp, 8

    mul  $v0, $a0, $v0

    jr   $ra

main:
    addi $a0, $zero, 3          # Set n = 3
    jal fact

    add $a0, $v0, $zero         # Store the result of fact at a0
    li $v0, 1                   # Option : print integer
    syscall
```

- Result



4.

- code

```
        .data
x:  .asciiz "as"
y:  .asciiz "Computer A"

        .text
strcpy:
    addi $sp, $sp, -4
    sw   $s0, 0($sp)
    add  $s0, $zero, $zero

L1: add  $t1, $s0, $a1
    lbu  $t2, 0($t1)
    add  $t3, $s0, $a0
    sb   $t2, 0($t3)
    beq  $t2, $zero, L2
    addi $s0, $s0, 1
    j    L1

L2: lw   $s0, 0($sp)
    addi $sp, $sp, 4
    jr   $ra


main:
    la $a0, x
    la $a1, y

    jal strcpy

    li $v0, 4                   # Option : print string
    syscall                     # Print x
```

- Result