BÁO CÁO THỰC HÀNH KIẾN TRÚC MÁY TÍNH

LAB 3

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ASSIGNMENT 1:

1. Code:

```
#Laboratory Exercise 3, Home Assignment 1
.text
          addi $s1, $zero, 10     # i = 10
          addi $s2, $zero, 11     # j = 11
          addi $t1, $zero, 2      # x = 2
          addi $t2, $zero, 3      # y = 3
          addi $t3, $zero, 4      # z = 4

start:
          slt  $t0, $s2, $s1      #j<1
          bne  $t0, $zero, else  # branch to else if j<i
          addi $t1, $t1, 1        # then part: x=x+1
          addi $t3, $zero, 1      # z=1
          j    endif              # skip "else" part
else:
        addi $t2, $t2, -1       # begin else part: y=y-1
        add  $t3, $t3, $t3      # z=2*z
endif:
```

2. Gán i = $s1 = 10 và j = $s2 = 11

$s1	17	0x0000000a
$s2	18	0x0000000b

3. Gán x = 2, y = 3, z = 4

$t1	9	0x00000002
$t2	10	0x00000003
$t3	11	0x00000004

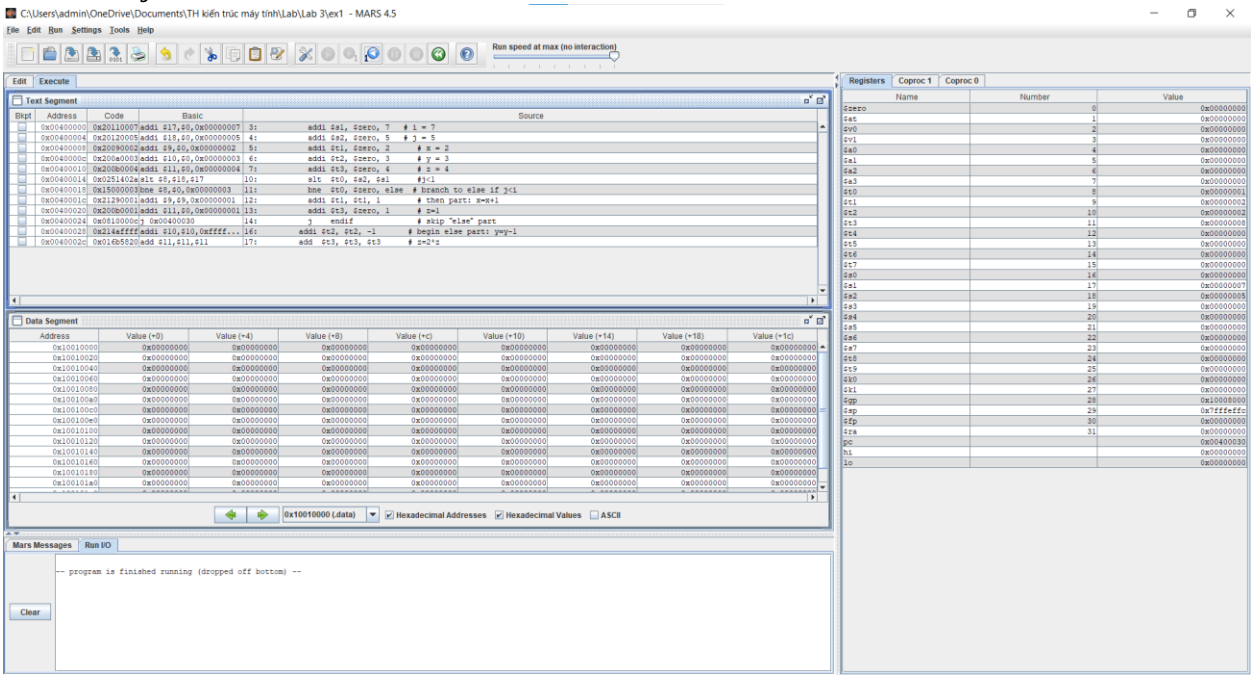
4. Sau khi chạy chương trình.

- Vì i<j nên x = x + 1 = 2 + 1 = 3

z = 1

$t1	9	0x00000003
$t2	10	0x00000003
$t3	11	0x00000001

5. Thử i = 7, j = 5



Vì i>j nên y = y – 1 = 6

z = 2*z = 8

ASSIGNMENT 2:

1. Code

Edit Execute

ex1* ex2.asm*

```
1  #Laboratory 3, Home Assigment 2
2  #PhamVanAnh_20214988
3
4  .data
5            A: .word 1, 2, 3, 4, 5, 6, 7, 9
6  .text
7            addi $s1, $zero, 0      #i = 0
8            addi $s4, $zero, 1      #step = 1
9            addi $s3, $zero, 8      #n = 8
10           la   $s2, A             #Load address A[0] to $s2
11           lw   $t0, 0($s2)        #Load value of A[0] to $t0
12           add  $s5, $zero, $t0    #sum = A[0]
13 loop:
14           add    $s1,$s1,$s4      #i=i+step
15           add    $t1,$s1,$s1      #t1=2*s1
16           add    $t1,$t1,$t1      #t1=4*s1
17           add    $t1,$t1,$s2      #t1 store the address of A[i]
18           lw     $t0,0($t1)       #load value of A[i] in$t0
19           add    $s5,$s5,$t0      #sum = sum+A[i]
20           bne    $s1,$s3,loop     #if i != n, go to loop
21
22
```

2. Gán i = 0, step = 1, n = 8

$s1	17	0x00000000
$s2	18	0x00000000
$s3	19	0x00000008
$s4	20	0x00000001

3. Gán địa chỉ của A[0] vào $s2
4. Gán giá trị của A[0] và $t0
5. Gán sum = A[0]

Registers | Coproc 1 | Coproc 0

Name	Number	Value
$zero	0	0x00000000
$at	1	0x10010000
$v0	2	0x00000000
$v1	3	0x00000000
$a0	4	0x00000000
$a1	5	0x00000000
$a2	6	0x00000000
$a3	7	0x00000000
$t0	8	0x00000001
$t1	9	0x00000000
$t2	10	0x00000000
$t3	11	0x00000000
$t4	12	0x00000000
$t5	13	0x00000000
$t6	14	0x00000000
$t7	15	0x00000000
$s0	16	0x00000000
$s1	17	0x00000000
$s2	18	0x10010000
$s3	19	0x00000008
$s4	20	0x00000001
$s5	21	0x00000000
$s6	22	0x00000000
$s7	23	0x00000000
$t8	24	0x00000000
$t9	25	0x00000000
$k0	26	0x00000000
$k1	27	0x00000000
$gp	28	0x10008000
$sp	29	0x7fffeffc
$fp	30	0x00000000
$ra	31	0x00000000
pc		0x00400018
hi		0x00000000
lo		0x00000000

6. Kết quả: sum(A) = 25, được lưu trong thanh ghi $s5

ASSIGNMENT 3:

1. Code

ex1* | ex2.asm | ex3.asm | mips4.asm

```
#Laboratory Exercise 3, Home Assignment 3
#PhamVanAnh_20214988
.data
   test: .word 0
.text
            add  $s2, $zero, 8 #a=8
            add  $s3, $zero, 9 #b=9

            la   $s0, test   #load the address of test variable\
            lw   $s1, 0($s0) #load the value of test to register$t1
            li   $t0, 0      #load value for test case
            li   $t1, 1
            li   $t2, 2
            beq  $s1, $t0, case_0
            beq  $s1, $t1, case_1
            beq  $s1, $t2, case_2
            j    default

case_0:
            addi $s2, $s2, 1         #a=a+1
            j    continue
case_1:
            sub $s2, $s2, $t1        #a=a-1
            j   continue
case_2:
            add $s3, $s3, $s3        #b=2*b
            j   continue
default:
continue:

```

2. Gán test = $s1 = 0
   Gán a = $s2 = 8 và b = $s3 = 9

$s2	18	0x00000008
$s3	19	0x00000009

3. Gán $t0 = 0, $t1 = 1, $t2 = 2

$t0	8	0x00000000
$t1	9	0x00000001
$t2	10	0x00000002

4. Test = 0 → Case_0:
   a = a + 1 = 8 + 1= 9

$s2	18	0x00000009

5. Test = 1 → Case_1:
   a = a – 1 = 8 – 1 = 7

6. Test = 2 → Case_2:
   b = b * 2

ASSIGNMENT 4

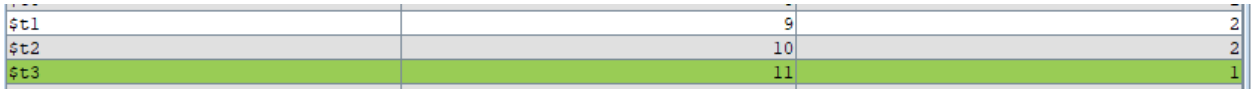
a) i < j

1. Code:

```
1  # Laboratory Exercise 3, Assignment 4
2  #PhamVanAnh_20214988
3  .data
4                   x: .word 1
5                   y: .word 2
6                   z: .word 3
7  .text
8                   addi    $s1, $zero, 8       # i = 8
9                   addi    $s2, $zero, 9       # j = 9
10                  la      $a0, x              # set $a0 to x's address
11                  lw      $t1, 0($a0)         # set $t1 to contents of y
12                  la      $a0, y              # set $a0 to y's address
13                  lw      $t2, 0($a0)         # set $t2 to contents of y
14                  la      $a0, z              # set $a0 to z's address
15                  lw      $t3, 0($a0)         # set $t3 to contents of z
16
17 start_a:
18                  slt     $t0, $s1, $s2       # i < j
19                  beq     $t0, $zero, else_a  # brach to else if i >= j
20                  addi    $t1, $t1, 1         # then part: x=x+1
21                  addi    $t3, $zero, 1       # z=1
22                  j       endif_a             # skip "else" part
23 else_a:   addi   $t2, $t2, -1                # begin else part: y=y-1
24                  add     $t3, $t3, $t3               # z=2*z
25 endif_a:
26
```

2. i và j được gán vào $s1 và $s2

3. x, y, z lần lượt được gán vào $t1, $t2, $t3



b) i >= j

1. Code

```
1  # Laboratory Exercise 3, Assignment 4
2  #PhamVanAnh_20214988
3  .data
4                       x: .word 1
5                       y: .word 2
6                       z: .word 3
7  .text
8                       addi    $s1, $zero, 8       # i = 8
9                       addi    $s2, $zero, 9       # j = 9
10                      la      $a0, x              # set $a0 to x's address
11                      lw      $t1, 0($a0)         # set $t1 to contents of y
12                      la      $a0, y              # set $a0 to y's address
13                      lw      $t2, 0($a0)         # set $t2 to contents of y
14                      la      $a0, z              # set $a0 to z's address
15                      lw      $t3, 0($a0)         # set $t3 to contents of z
16
17 start_b:
18                      slt     $t0, $s1, $s2       # i < j
19                      bne     $t0, $zero, else_b  # brach to else if i < j
20                      addi    $t1, $t1, 1         # then part: x=x+1
21                      addi    $t3, $zero, 1       # z=1
22                      j       endif_b             # skip "else" part
23 else_b:              addi    $t2, $t2, -1        # begin else part: y=y-1
24                      add     $t3, $t3, $t3       # z=2*z
25 endif_b:
```

2. i và j được gán vào $s1 và $s2

$s1	17	8
$s2	18	9

3. x, y, z lần lượt được gán vào $t1, $t2, $t3

$t1	9	1
$t2	10	1
$t3	11	6

c) i + j <= 0

1. Code

```
1  # Laboratory Exercise 3, Assignment 4
2  #PhamVanAnh_20214988
3  .data
4                      x: .word 1
5                      y: .word 2
6                      z: .word 3
7  .text
8                      addi      $s1, $zero, 8       # i = 8
9                      addi      $s2, $zero, 9       # j = 9
10                     la        $a0, x              # set $a0 to x's address
11                     lw        $t1, 0($a0)         # set $t1 to contents of y
12                     la        $a0, y              # set $a0 to y's address
13                     lw        $t2, 0($a0)         # set $t2 to contents of y
14                     la        $a0, z              # set $a0 to z's address
15                     lw        $t3, 0($a0)         # set $t3 to contents of z
16
17 start_c:
18                     add       $t4, $s1, $s2                 # $t4 = i + j
19                     sgt $t0, $t4, 0          # i + j > 0
20                     bne       $t0, $zero, else_c  # brach to else if i + j > 0
21                     addi      $t1, $t1, 1                   # then part: x=x+1
22                     addi      $t3, $zero, 1       # z=1
23                     j         endif_c                           # skip “else” part
24 else_c:   addi      $t2, $t2, -1        # begin else part: y=y-1
25                     add       $t3, $t3, $t3                 # z=2*z
26 endif_c:
27
```

1. i và j được gán vào $s1 và $s2

$s1	17	8
$s2	18	9

2. x, y, z lần lượt được gán vào $t1, $t2, $t3

$t1	9	1
$t2	10	1
$t3	11	6

d) i + j > m + n

1. Code

```
# Laboratory Exercise 3, Assignment 4
#PhamVanAnh_20214988
.data
                    x: .word 1
                    y: .word 2
                    z: .word 3
.text
                    addi      $s1, $zero, 8       # i = 8
                    addi      $s2, $zero, 9       # j = 9
                    la        $a0, x              # set $a0 to x's address
                    lw        $t1, 0($a0)         # set $t1 to contents of y
                    la        $a0, y              # set $a0 to y's address
                    lw        $t2, 0($a0)         # set $t2 to contents of y
                    la        $a0, z              # set $a0 to z's address
                    lw        $t3, 0($a0)         # set $t3 to contents of z

start_d:
                    add       $s6, $zero, 6                 # m = 6
                    add $s7, $zero, 7             # n = 7
                    add       $t4, $s1, $s2                 # $t4 = i + j
                    add       $t5, $s6, $s7                 # $t5 = m + n
                    sgt $t0, $t4, $t5       # i + j > m + n
                    beq       $t0, $zero, else_d  # brach to else if i + j > m + b
                    addi      $t1, $t1, 1                   # then part: x=x+1
                    addi      $t3, $zero, 1       # z=1
                    j         endif_d                           # skip “else” part
else_d:   addi      $t2, $t2, -1        # begin else part: y=y-1
                    add       $t3, $t3, $t3                 # z=2*z
endif_d:
```

1. i và j được gán vào $s1 và $s2

$s1	17	8
$s2	18	9

2. x, y, z lần lượt được gán vào $t1, $t2, $t3

$t1	9	2
$t2	10	2
$t3	11	1

ASSIGNMENT 5:

a) i<n

1. Code

```
# Laboratory Exercise 3, Assignment 5
# PhamVanAnh_20214988
.data
          A: .word -3, -5, -10, 4, 7, 9
.text
          addi $s1, $zero, 0      # i = 0
          addi $s4, $zero, 1      # step = 1
          addi $s3, $zero, 6      # n = 6
          la $s2, A               # Load address A[0] to $s2
          lw $t0, 0($s2)          # Load value of A[0] in $t0
          add $s5, $zero,$t0      # sum = A[0]

loop_a:
          add $s1,$s1,$s4         #i=i+step
          add $t1,$s1,$s1         #t1=2*s1
          add $t1,$t1,$t1         #t1=4*s1
          add $t1,$t1,$s2         #t1 store the address of A[i]
          lw  $t0,0($t1)          #load value of A[i] in $t0
          add $s5,$s5,$t0         #sum=sum+A[i]
          slt $t2,$s1,$s3         # i < n
          bne $t2,$zero,loop_a    #if i < n, goto loop_a

```

2. Gán i = $s1, n = $s3
3. So sánh $s1 < $s3
    - Đúng → $t2 = 1
    - Sai → $t2 = 0
4. So sánh $t2 với 0
    - i >= n → kết thúc vòng lặp
    - i < n → quay lại loop_a
5. Kết quả

Registers | Coproc 1 | Coproc 0

Name	Number	Value
$zero	0	0
$at	1	268500992
$v0	2	0
$v1	3	0
$a0	4	0
$a1	5	0
$a2	6	0
$a3	7	0
$t0	8	0
$t1	9	268501016
$t2	10	0
$t3	11	0
$t4	12	0
$t5	13	0
$t6	14	0
$t7	15	0
$s0	16	0
$s1	17	6
$s2	18	268500992
$s3	19	6
$s4	20	1
$s5	21	2
$s6	22	0
$s7	23	0
$t8	24	0
$t9	25	0
$k0	26	0
$k1	27	0
$gp	28	268468224
$sp	29	2147479548
$fp	30	0
$ra	31	0
pc		4194364
hi		0
lo		0

b) i<=n

1. Code

```
# Laboratory Exercise 3, Assignment 5
# PhamVanAnh_20214988
.data
          A: .word -3, -5, -10, 4, 7, 9
.text
          addi $s1, $zero, 0      # i = 0
          addi $s4, $zero, 1      # step = 1
          addi $s3, $zero, 6      # n = 6
          la $s2, A               # Load address A[0] to $s2
          lw $t0, 0($s2)          # Load value of A[0] in $t0
          add $s5, $zero,$t0      # sum = A[0]

loop_b:
          add $s1,$s1,$s4 #i=i+step
          add $t1,$s1,$s1 #t1=2*s1
          add $t1,$t1,$t1 #t1=4*s1
          add $t1,$t1,$s2 #t1 store the address of A[i]
          lw  $t0,0($t1)  #load value of A[i] in $t0
          add $s5,$s5,$t0 #sum=sum+A[i]
          sgt $t2,$s1,$s3 # i > n
          beq $t2,$zero,loop_b#if i <= n, goto loop_b

```

2. Gán i = $s1, n = $s3
3. So sánh $s1 > $s3:
    - Đúng $t2 = 1
    - Sai $t2 = 0
4. So sánh $t2 với 0:
    - i <= n → quay lại loop_b
    - i>n → kết thúc

5. Kết quả

Registers | Coproc 1 | Coproc 0

Name	Number	Value
$zero	0	0
$at	1	268500992
$v0	2	0
$v1	3	0
$a0	4	0
$a1	5	0
$a2	6	0
$a3	7	0
$t0	8	0
$t1	9	268501020
$t2	10	1
$t3	11	0
$t4	12	0
$t5	13	0
$t6	14	0
$t7	15	0
$s0	16	0
$s1	17	7
$s2	18	268500992
$s3	19	6
$s4	20	1
$s5	21	2
$s6	22	0
$s7	23	0
$t8	24	0
$t9	25	0
$k0	26	0
$k1	27	0
$gp	28	268468224
$sp	29	2147479548
$fp	30	0
$ra	31	0
pc		4194364
hi		0
lo		0

c) sum>=0

1. Code

ex1* | ex2.asm | ex3.asm | ex4.asm | ex5.asm

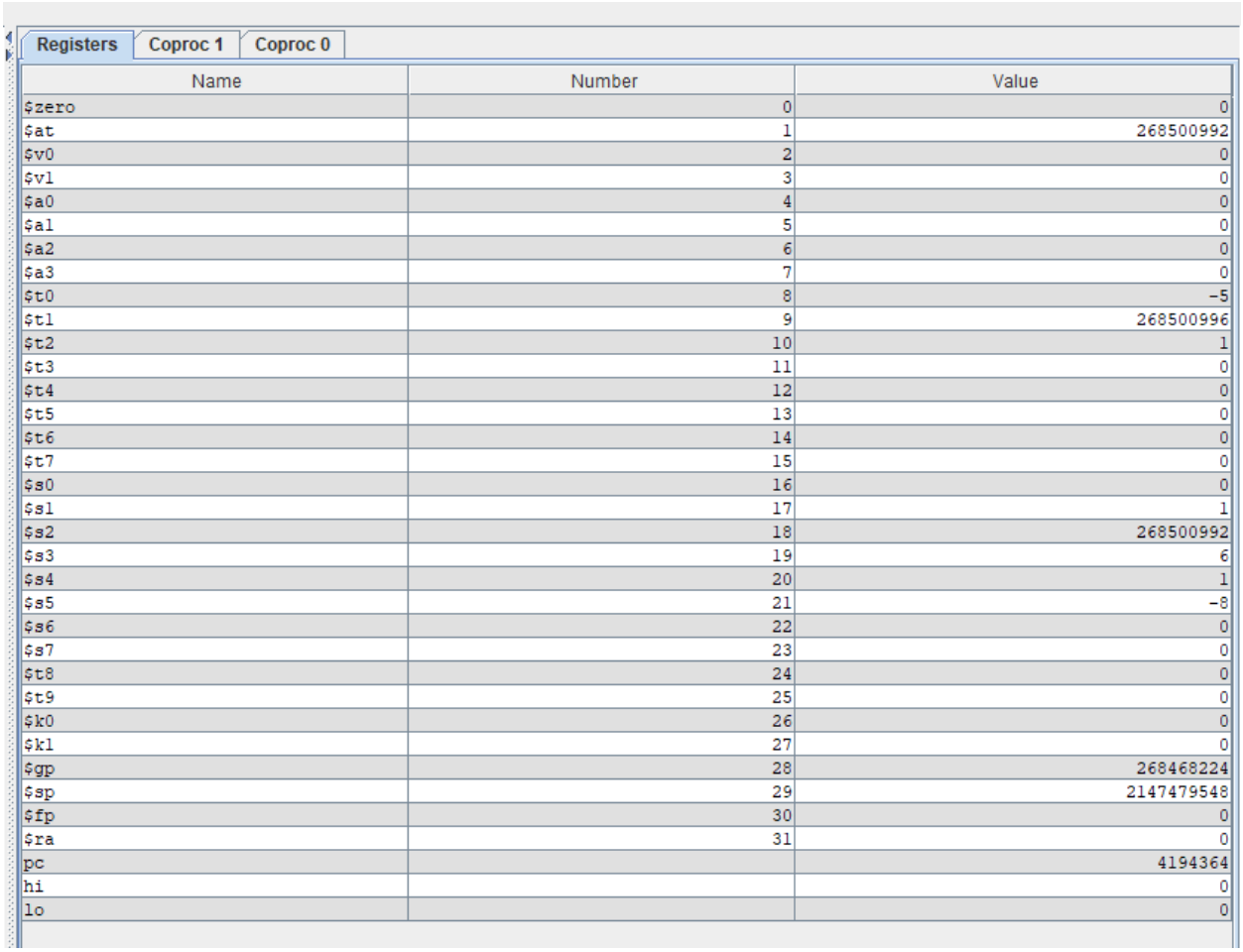
```
# Laboratory Exercise 3, Assignment 5
# PhamVanAnh_20214988
.data
          A: .word -3, -5, -10, 4, 7, 9
.text
          addi $s1, $zero, 0      # i = 0
          addi $s4, $zero, 1      # step = 1
          addi $s3, $zero, 6      # n = 6
          la $s2, A               # Load address A[0] to $s2
          lw $t0, 0($s2)          # Load value of A[0] in $t0
          add $s5, $zero,$t0      # sum = A[0]

loop_c:
          add $s1,$s1,$s4 #i=i+step
          add $t1,$s1,$s1 #t1=2*s1
          add $t1,$t1,$t1 #t1=4*s1
          add $t1,$t1,$s2 #t1 store the address of A[i]
          lw  $t0,0($t1)  #load value of A[i] in $t0
          add $s5,$s5,$t0 #sum=sum+A[i]
          slt $t2,$s5,$zero# sum < 0
          beq $t2,$zero,loop_c#if sum >= 0, goto loop_c

```

2. i = $s1, n = $s3, sum = $s5
3. So sánh $s5 < 0
    - Đúng $t2 =1
    - Sai $t2 = 0
4. So sánh $t2 với 0
    - Sum = 0 → loop_c
    - Sum <0 → kết thúc

5. Kết quả



Registers | Coproc 1 | Coproc 0

Name	Number	Value
$zero	0	0
$at	1	268500992
$v0	2	0
$v1	3	0
$a0	4	0
$a1	5	0
$a2	6	0
$a3	7	0
$t0	8	-5
$t1	9	268500996
$t2	10	1
$t3	11	0
$t4	12	0
$t5	13	0
$t6	14	0
$t7	15	0
$s0	16	0
$s1	17	1
$s2	18	268500992
$s3	19	6
$s4	20	1
$s5	21	-8
$s6	22	0
$s7	23	0
$t8	24	0
$t9	25	0
$k0	26	0
$k1	27	0
$gp	28	268468224
$sp	29	2147479548
$fp	30	0
$ra	31	0
pc		4194364
hi		0
lo		0

d) A[i] == 0

1. Code

```
# Laboratory Exercise 3, Assignment 5
# PhamVanAnh_20214988
.data
          A: .word -3, -5, -10, 4, 7, 9
.text
          addi $s1, $zero, 0      # i = 0
          addi $s4, $zero, 1      # step = 1
          addi $s3, $zero, 6      # n = 6
          la $s2, A               # Load address A[0] to $s2
          lw $t0, 0($s2)          # Load value of A[0] in $t0
          add $s5, $zero,$t0      # sum = A[0]
loop_d:
          add $s1,$s1,$s4 #i=i+step
          add $t1,$s1,$s1 #t1=2*s1
          add $t1,$t1,$t1 #t1=4*s1
          add $t1,$t1,$s2 #t1 store the address of A[i]
          lw  $t0,0($t1)  #load value of A[i] in $t0
          add $s5,$s5,$t0 #sum=sum+A[i]
          beq $t0,$zero,loop_d#if A[i]==0, goto loop_d

```

2. A[i] = $t0
3. So sánh $t0 với 0:
    - A[i] == 0 → loop_d
    - A[i] != 0 → Kết thúc

4. Kết quả

Registers | Coproc 1 | Coproc 0

Name	Number	Value
$zero	0	0
$at	1	268500992
$v0	2	0
$v1	3	0
$a0	4	0
$a1	5	0
$a2	6	0
$a3	7	0
$t0	8	-5
$t1	9	268500996
$t2	10	0
$t3	11	0
$t4	12	0
$t5	13	0
$t6	14	0
$t7	15	0
$s0	16	0
$s1	17	1
$s2	18	268500992
$s3	19	6
$s4	20	1
$s5	21	-8
$s6	22	0
$s7	23	0
$t8	24	0
$t9	25	0
$k0	26	0
$k1	27	0
$gp	28	268468224
$sp	29	2147479548
$fp	30	0
$ra	31	0
pc		4194360
hi		0
lo		0

ASSIGNMENT 6:

1. Code

```
# PhamVanAnh_20214988
.data
A: .word -1, -2, -3, -11, 1, 2, 3, 4, 5, 6, 7, 8, 9

.text
      li $s1, -1          #i=-1
      la $s2, A           #s2 stores the address of array A
      li $s3, 13          #number of element of A
      li $s4, 1           #step
      li $s5, 0           #max
loop:
      add $s1, $s1, $s4
      add $t1, $s1, $s1   #t1=2*s1
      add $t1, $t1, $t1   #t1=4*s1
      add $t1, $t1, $s2   #t1 store the address of A[i]
      lw  $t0, 0($t1)     #load value of A[i] in$t0
      beq $s1, $s3, end

      slt $t2, $zero, $t0 #so sanh A[i] v?i 0. N?u A[i]>0, t2 =1 => chay tiep
      beq $t2, $zero, a   #so sánh t2 và 0. Neu t2=0 thì quay xuong ham a (truong hop A[i]<0)
      slt $s7, $s5, $t0   # 1: 0 ? s5 < A[i]
      beq $s7, $0, loop   #neu s7 = 0 thì quay lai loop
      add $s5, $0, $t0    #gán s5 thành A[i]
      j loop
a:
      sub $s6, $0, $t0   #V?i A[i]<0, dùng sub 0-A[i]
      slt $s7, $s5, $s6  # 1: 0 ? s5 < s6
      beq $s7, $0, loop
      add $s5, $0, $s6
      j loop
 end:
```

2. Max được gán vào $s5
3. Kết quả là:

Registers | Coproc 1 | Coproc 0

Name	Number	Value
$zero	0	0x00000000
$at	1	0x10010000
$v0	2	0x00000000
$v1	3	0x00000000
$a0	4	0x00000000
$a1	5	0x00000000
$a2	6	0x00000000
$a3	7	0x00000000
$t0	8	0x00000000
$t1	9	0x10010034
$t2	10	0x00000001
$t3	11	0x00000000
$t4	12	0x00000000
$t5	13	0x00000000
$t6	14	0x00000000
$t7	15	0x00000000
$s0	16	0x00000000
$s1	17	0x0000000d
$s2	18	0x10010000
$s3	19	0x0000000d
$s4	20	0x00000001
$s5	21	0x0000000b
$s6	22	0x0000000b
$s7	23	0x00000000
$t8	24	0x00000000
$t9	25	0x00000000
$k0	26	0x00000000
$k1	27	0x00000000
$gp	28	0x10008000
$sp	29	0x7fffeffc
$fp	30	0x00000000
$ra	31	0x00000000
pc		0x0040005c
hi		0x00000000
lo		0x00000000