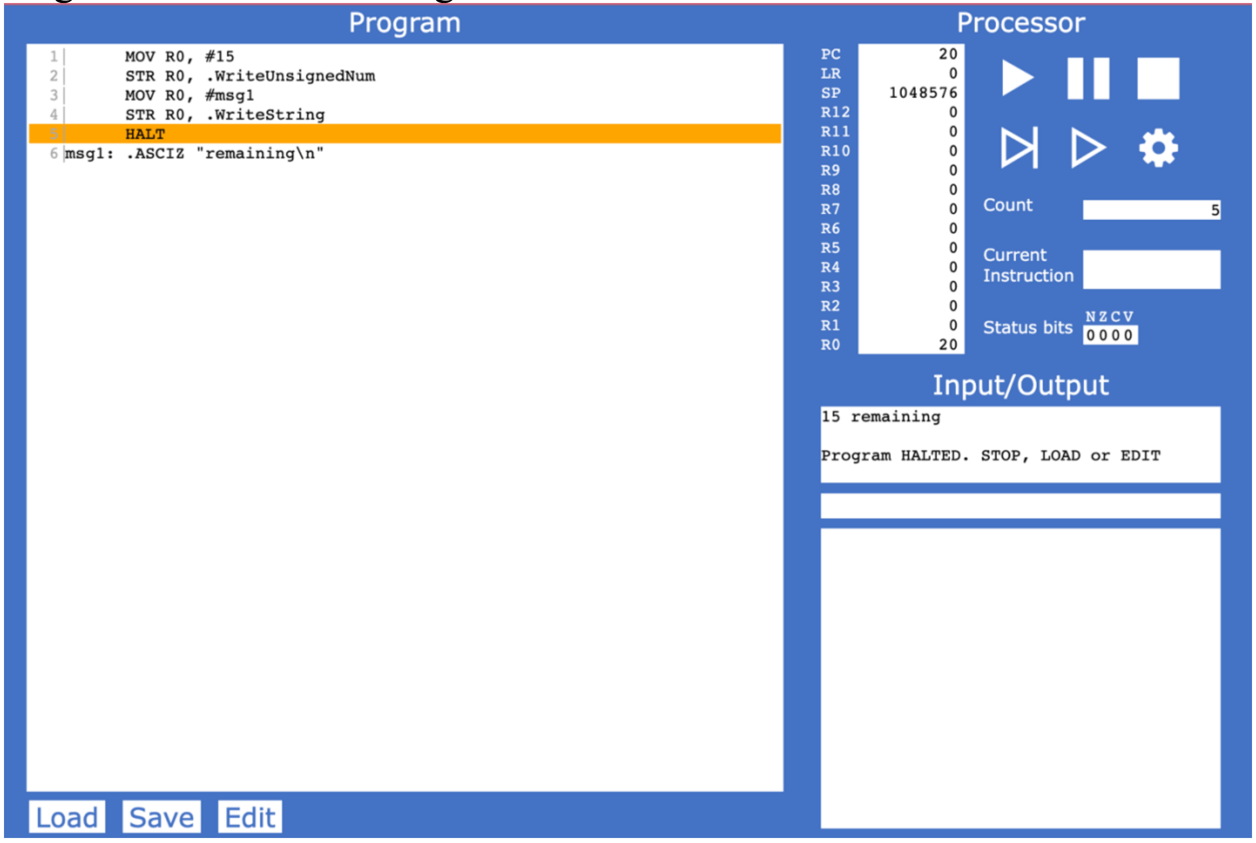
COS10004 – Computer System
Name: Phan Vũ – Student Id: 104222099
LAB 8

8.1.1

```
        MOV R0, #15
        STR R0, .WriteUnsignedNum
        MOV R0, #msg1
        STR R0, .WriteString
        HALT

msg1: .ASCIZ "remaining\n"
```



```
        MOV R0, #15
        STR R0, .WriteUnsignedNum
        MOV R0, #msg1
        STR R0, .WriteString
        HALT
msg1: .ASCIZ "remaining\n"
```

```
PC        20
LR         0
SP   1048576
R12        0
R11        0
R10        0
R9         0
R8         0
R7         0
R6         0
R5         0
R4         0
R3         0
R2         0
R1         0
R0        20
```

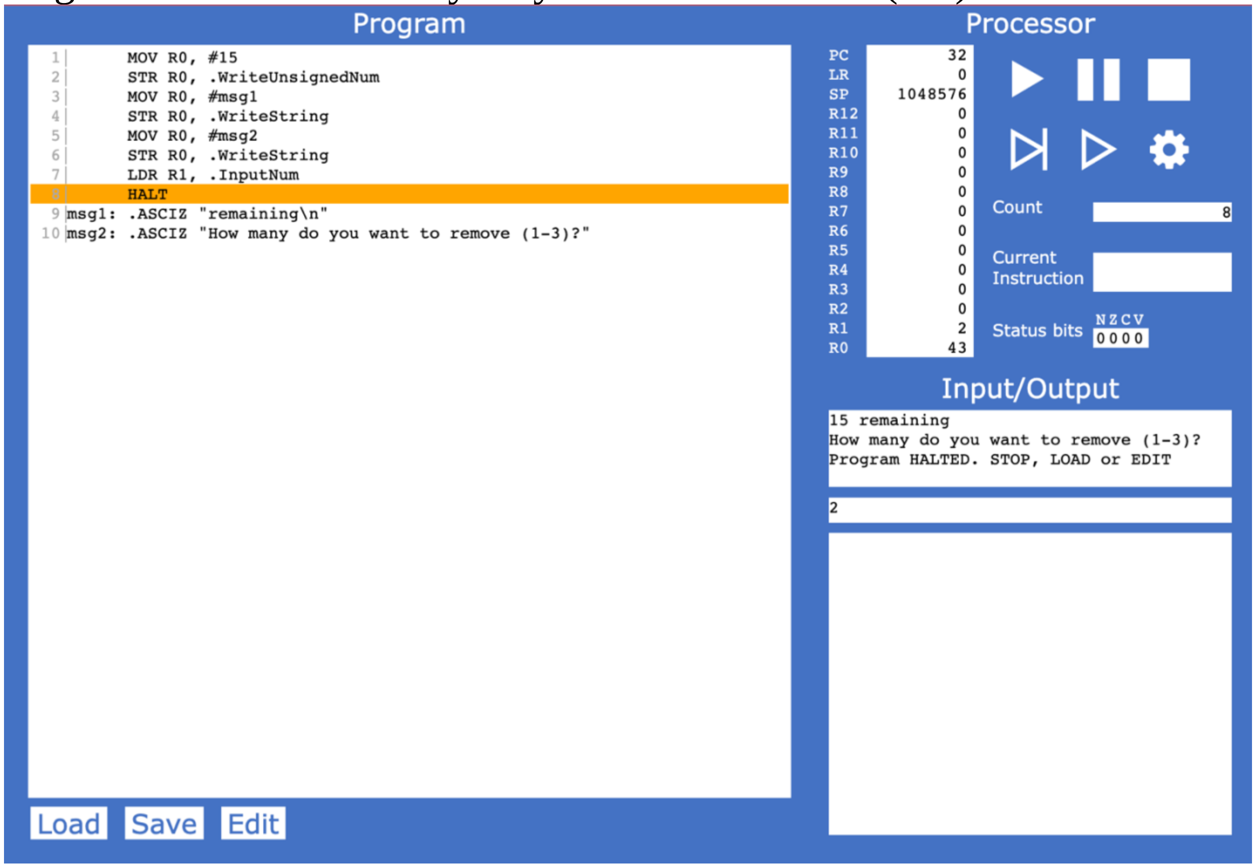
Count 5

Status bits N Z C V 0 0 0 0

```
15 remaining

Program HALTED. STOP, LOAD or EDIT
```

8.1.2.

```
        MOV R0, #15
        STR R0, .WriteUnsignedNum
        MOV R0, #msg1
        STR R0, .WriteString
        MOV R0, #msg2
        STR R0, .WriteString
        LDR R1, .InputNum
        HALT
msg1: .ASCIZ "remaining\n"
msg2: .ASCIZ "How many do you want to remove (1-3)?"
```



```
        MOV R0, #15
        STR R0, .WriteUnsignedNum
        MOV R0, #msg1
        STR R0, .WriteString
        MOV R0, #msg2
        STR R0, .WriteString
        LDR R1, .InputNum
        HALT
msg1: .ASCIZ "remaining\n"
msg2: .ASCIZ "How many do you want to remove (1-3)?"
```

```
PC   32
LR   0
SP   1048576
R12  0
R11  0
R10  0
R9   0
R8   0
R7   0
R6   0
R5   0
R4   0
R3   0
R2   0
R1   2
R0   43
```

Count 8

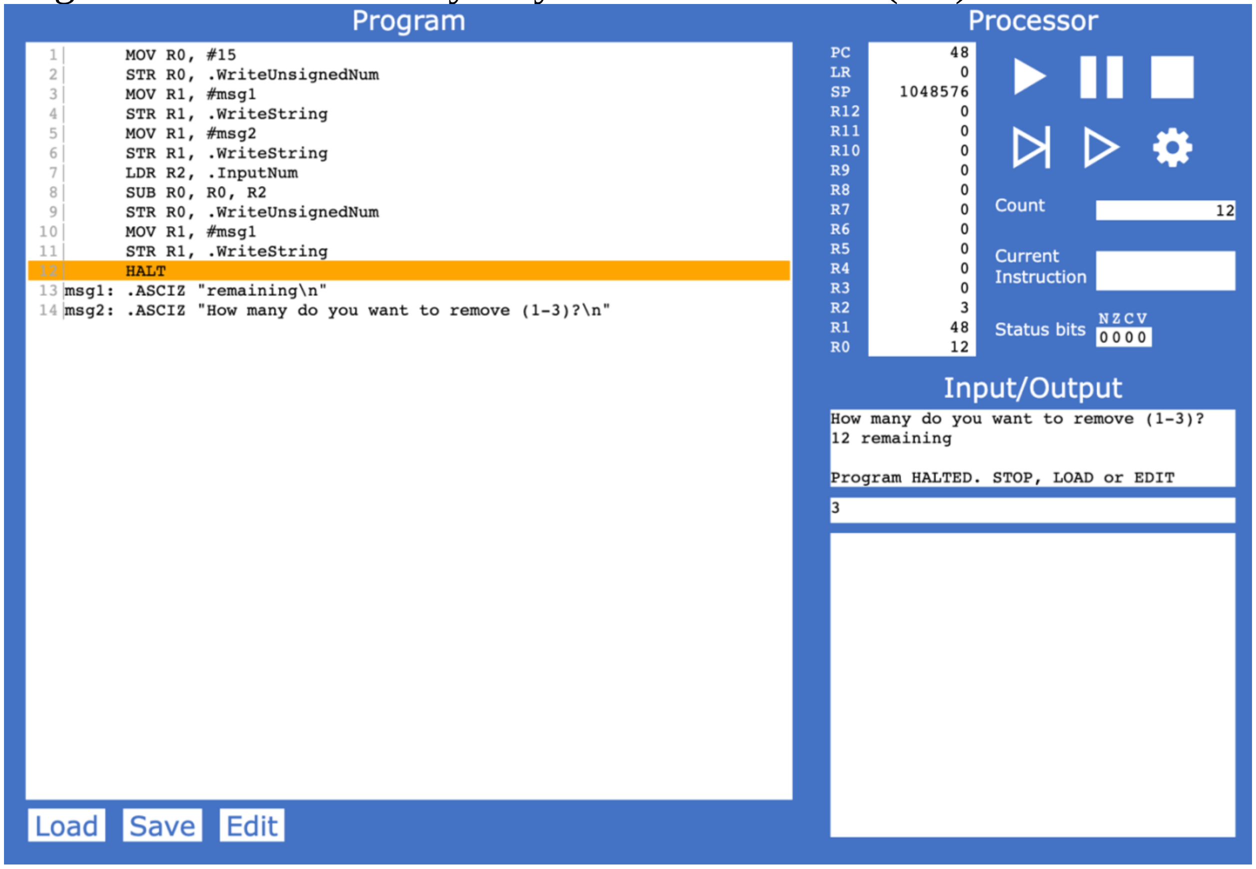
Status bits N Z C V 0 0 0 0

```
15 remaining
How many do you want to remove (1-3)?
Program HALTED. STOP, LOAD or EDIT
```

```
2
```

8.1.3.

```
    MOV R0, #15
    STR R0, .WriteUnsignedNum
    MOV R1, #msg1
    STR R1, .WriteString
    MOV R1, #msg2
    STR R1, .WriteString
    LDR R2, .InputNum
    SUB R0, R0, R2
    STR R0, .WriteUnsignedNum
    MOV R1, #msg1
    STR R1, .WriteString
    HALT
msg1: .ASCIZ "remaining\n"
msg2: .ASCIZ "How many do you want to remove (1-3)?\n"
```



```
        MOV R0, #15
        STR R0, .WriteUnsignedNum
        MOV R1, #msg1
        STR R1, .WriteString
        MOV R1, #msg2
        STR R1, .WriteString
        LDR R2, .InputNum
        SUB R0, R0, R2
        STR R0, .WriteUnsignedNum
        MOV R1, #msg1
        STR R1, .WriteString
        HALT
msg1: .ASCIZ "remaining\n"
msg2: .ASCIZ "How many do you want to remove (1-3)?\n"
```

PC 48
LR 0
SP 1048576
R12 0
R11 0
R10 0
R9 0
R8 0
R7 0
R6 0
R5 0
R4 0
R3 0
R2 3
R1 48
R0 12

Count 12
Status bits NZCV 0000

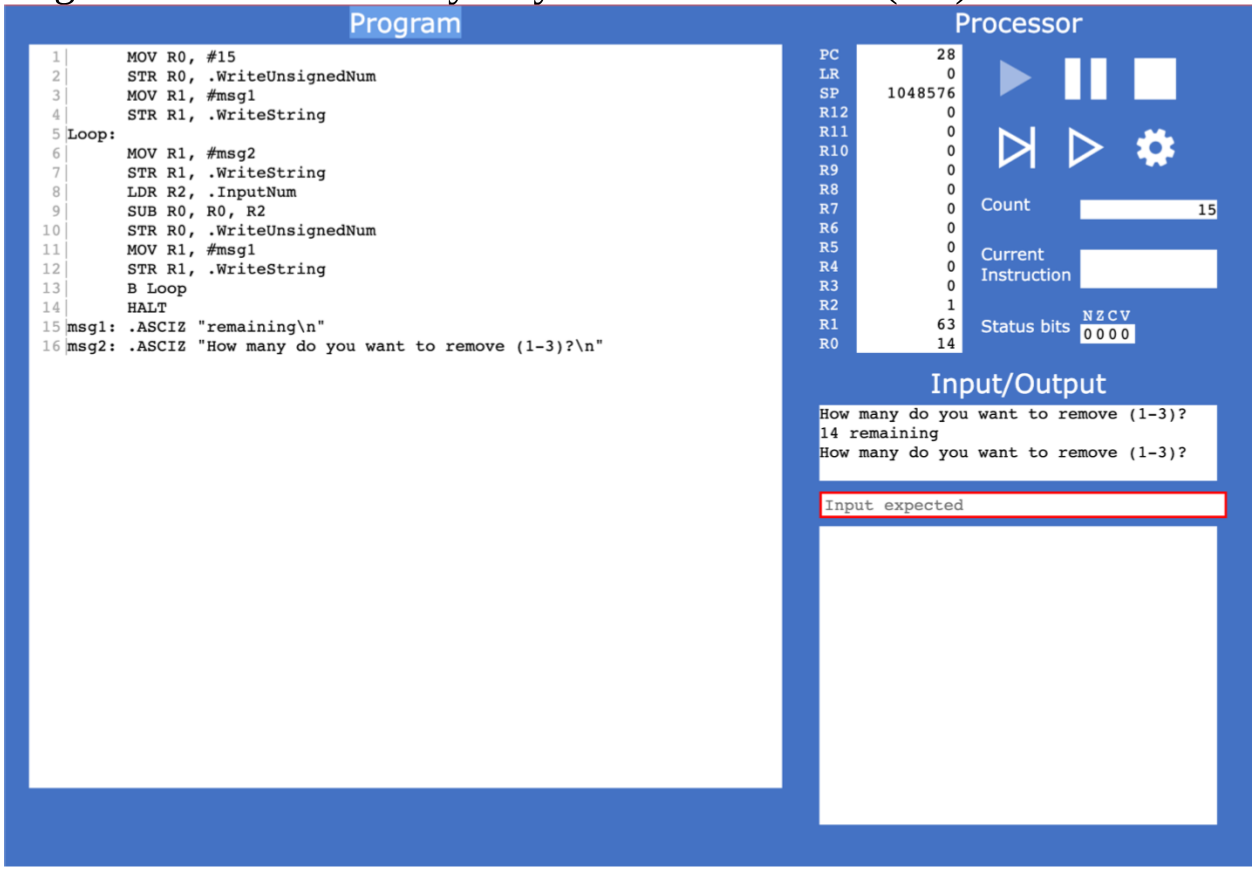
```
How many do you want to remove (1-3)?
12 remaining

Program HALTED. STOP, LOAD or EDIT
```

3

8.2.1

```
    MOV R0, #15
    STR R0, .WriteUnsignedNum
    MOV R1, #msg1
    STR R1, .WriteString
Loop:
    MOV R1, #msg2
    STR R1, .WriteString
    LDR R2, .InputNum
```

```
        SUB R0, R0, R2
        STR R0, .WriteUnsignedNum
        MOV R1, #msg1
        STR R1, .WriteString
        B Loop
        HALT
msg1: .ASCIZ "remaining\n"
msg2: .ASCIZ "How many do you want to remove (1-3)?\n"
```



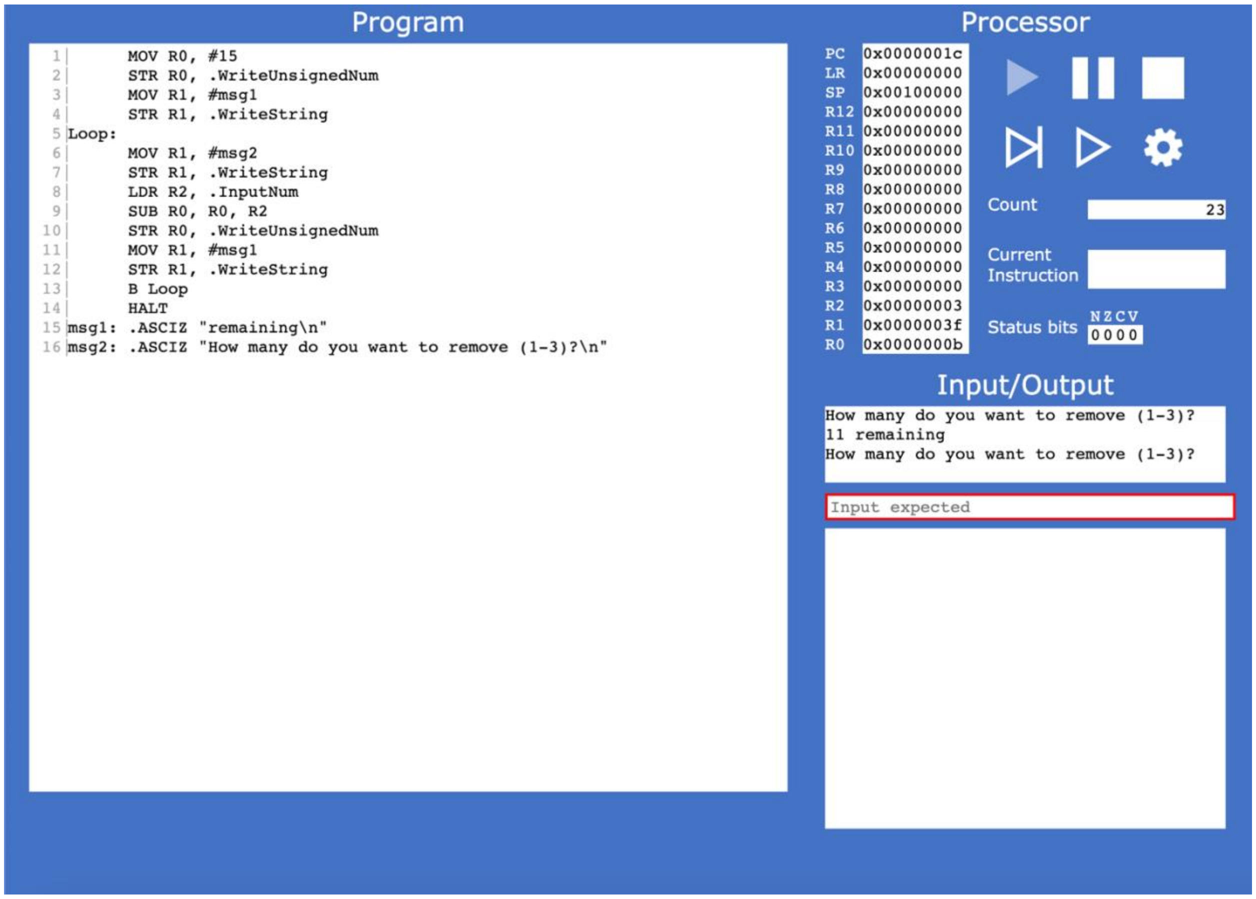
```
        MOV R0, #15
        STR R0, .WriteUnsignedNum
        MOV R1, #msg1
        STR R1, .WriteString
Loop:
        MOV R1, #msg2
        STR R1, .WriteString
        LDR R2, .InputNum
        SUB R0, R0, R2
        STR R0, .WriteUnsignedNum
        MOV R1, #msg1
        STR R1, .WriteString
        B Loop
        HALT
msg1: .ASCIZ "remaining\n"
msg2: .ASCIZ "How many do you want to remove (1-3)?\n"
```

```
PC        28
LR         0
SP   1048576
R12        0
R11        0
R10        0
R9         0
R8         0
R7         0
R6         0
R5         0
R4         0
R3         0
R2         1
R1        63
R0        14
```

Count 15

Status bits 0 0 0 0

```
How many do you want to remove (1-3)?
14 remaining
How many do you want to remove (1-3)?
```



```
      MOV R0, #15
      STR R0, .WriteUnsignedNum
      MOV R1, #msg1
      STR R1, .WriteString
Loop:
      MOV R1, #msg2
      STR R1, .WriteString
      LDR R2, .InputNum
      SUB R0, R0, R2
      STR R0, .WriteUnsignedNum
      MOV R1, #msg1
      STR R1, .WriteString
      B Loop
      HALT
msg1: .ASCIZ "remaining\n"
msg2: .ASCIZ "How many do you want to remove (1-3)?\n"
```

```
PC  0x0000001c
LR  0x00000000
SP  0x00100000
R12 0x00000000
R11 0x00000000
R10 0x00000000
R9  0x00000000
R8  0x00000000
R7  0x00000000
R6  0x00000000
R5  0x00000000
R4  0x00000000
R3  0x00000000
R2  0x00000003
R1  0x0000003f
R0  0x0000000b
```

Count 23

Status bits NZCV 0000

```
How many do you want to remove (1-3)?
11 remaining
How many do you want to remove (1-3)?
```

Input expected

If you enter a number that takes the number of matchsticks remaining beyond 0 (i.e., into negative values), the remaining number will still be calculated as normal, for example we are having 10 matchsticks and we remove -1 matchsticks, then the new number will be 11 matchsticks.

8.2.2

(a) $0 < R2 < 4$

(b)

Two assembly instructions could be used to create a branch that only occurs under this condition: BGT and BLT.

BGT: Z clear, N and V the same

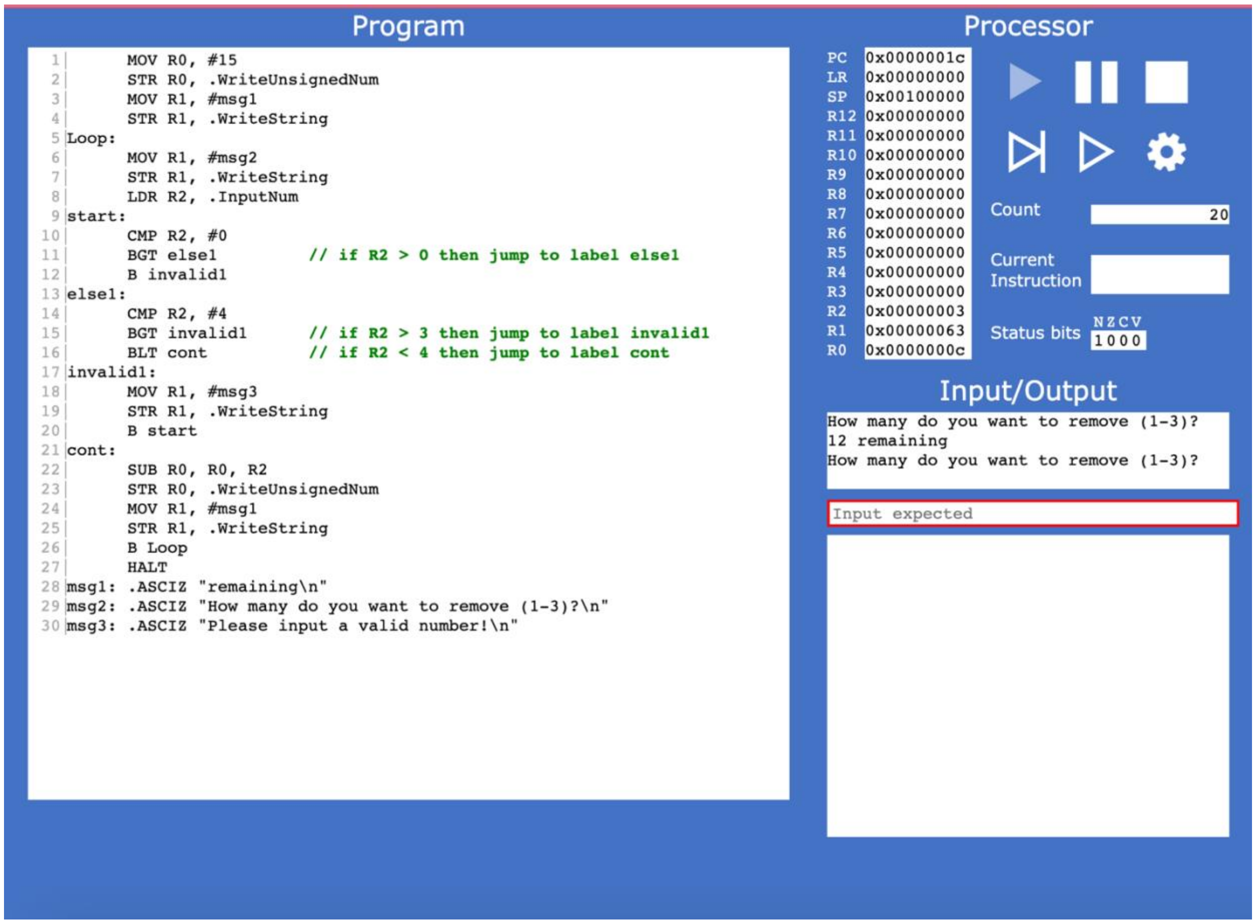
BLT: N and V differ

(c) If the first condition is not met ($R2 > 0$), and R2 is negative then N = 1. If the first condition is not met ($R2 > 0$), and R2 = 0 then Z = 1.

If the second condition is not met (R2 < 4), and R2 > 4 then C = 1. If the second condition is not met (R2 < 4), and R2 = 4 then both Z = 1 and C = 1.

(d)

```
        MOV R0, #15
        STR R0, .WriteUnsignedNum
        MOV R1, #msg1
        STR R1, .WriteString
Loop:
        MOV R1, #msg2
        STR R1, .WriteString
        LDR R2, .InputNum
start:
        CMP R2, #0
        BGT else1          // if R2 > 0 then jump to label else1
        B invalid1
else1:
        CMP R2, #4
        BGT invalid1       // if R2 > 3 then jump to label invalid1
        BLT cont           // if R2 < 4 then jump to label cont
invalid1:
        MOV R1, #msg3
        STR R1, .WriteString
        B start
cont:
        SUB R0, R0, R2
        STR R0, .WriteUnsignedNum
        MOV R1, #msg1
        STR R1, .WriteString
        B Loop
        HALT
msg1: .ASCIZ "remaining\n"
msg2: .ASCIZ "How many do you want to remove (1-3)?\n"
msg3: .ASCIZ "Please input a valid number!\n"
```



```
        MOV R0, #15
        STR R0, .WriteUnsignedNum
        MOV R1, #msg1
        STR R1, .WriteString
Loop:
        MOV R1, #msg2
        STR R1, .WriteString
        LDR R2, .InputNum
start:
        CMP R2, #0
        BGT else1           // if R2 > 0 then jump to label else1
        B invalid1
else1:
        CMP R2, #4
        BGT invalid1        // if R2 > 3 then jump to label invalid1
        BLT cont            // if R2 < 4 then jump to label cont
invalid1:
        MOV R1, #msg3
        STR R1, .WriteString
        B start
cont:
        SUB R0, R0, R2
        STR R0, .WriteUnsignedNum
        MOV R1, #msg1
        STR R1, .WriteString
        B Loop
        HALT
msg1: .ASCIZ "remaining\n"
msg2: .ASCIZ "How many do you want to remove (1-3)?\n"
msg3: .ASCIZ "Please input a valid number!\n"
```

```
PC  0x0000001c
LR  0x00000000
SP  0x00100000
R12 0x00000000
R11 0x00000000
R10 0x00000000
R9  0x00000000
R8  0x00000000
R7  0x00000000
R6  0x00000000
R5  0x00000000
R4  0x00000000
R3  0x00000000
R2  0x00000003
R1  0x00000063
R0  0x0000000c
```

Count 20

Status bits N Z C V: 1 0 0 0

```
How many do you want to remove (1-3)?
12 remaining
How many do you want to remove (1-3)?
```

Input expected

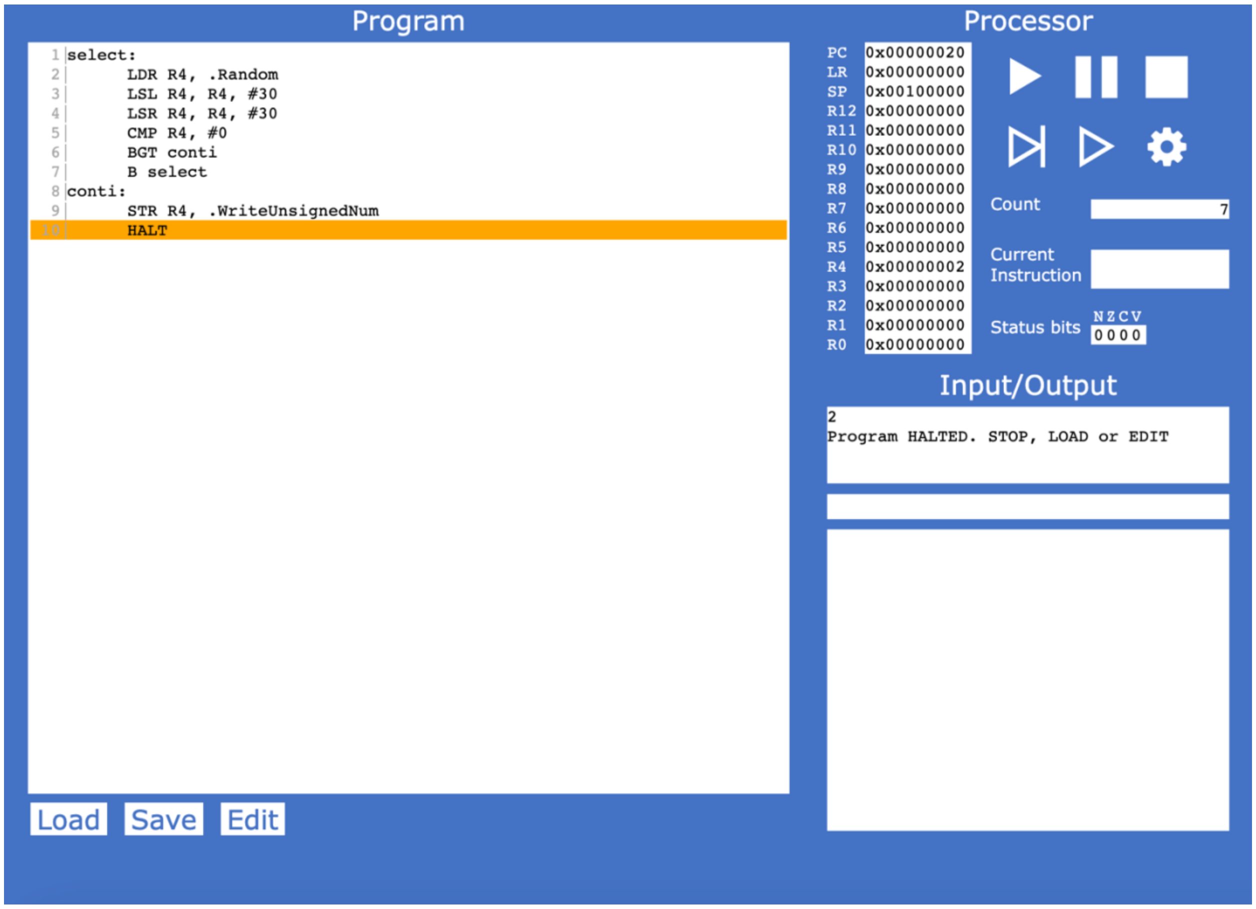
8.3.1

(a)

```
LSL R4, R4, #30
LSR R4, R4, #30
```

(b)

```
select:
        LDR R4, .Random
        LSL R4, R4, #30
        LSR R4, R4, #30
        CMP R4, #0
        BGT conti
        B select
conti:
        STR R4, .WriteUnsignedNum
        HALT
```



```
select:
      LDR R4, .Random
      LSL R4, R4, #30
      LSR R4, R4, #30
      CMP R4, #0
      BGT conti
      B select
conti:
      STR R4, .WriteUnsignedNum
      HALT
```

```
PC  0x00000020
LR  0x00000000
SP  0x00100000
R12 0x00000000
R11 0x00000000
R10 0x00000000
R9  0x00000000
R8  0x00000000
R7  0x00000000
R6  0x00000000
R5  0x00000000
R4  0x00000002
R3  0x00000000
R2  0x00000000
R1  0x00000000
R0  0x00000000
```

Count: 7

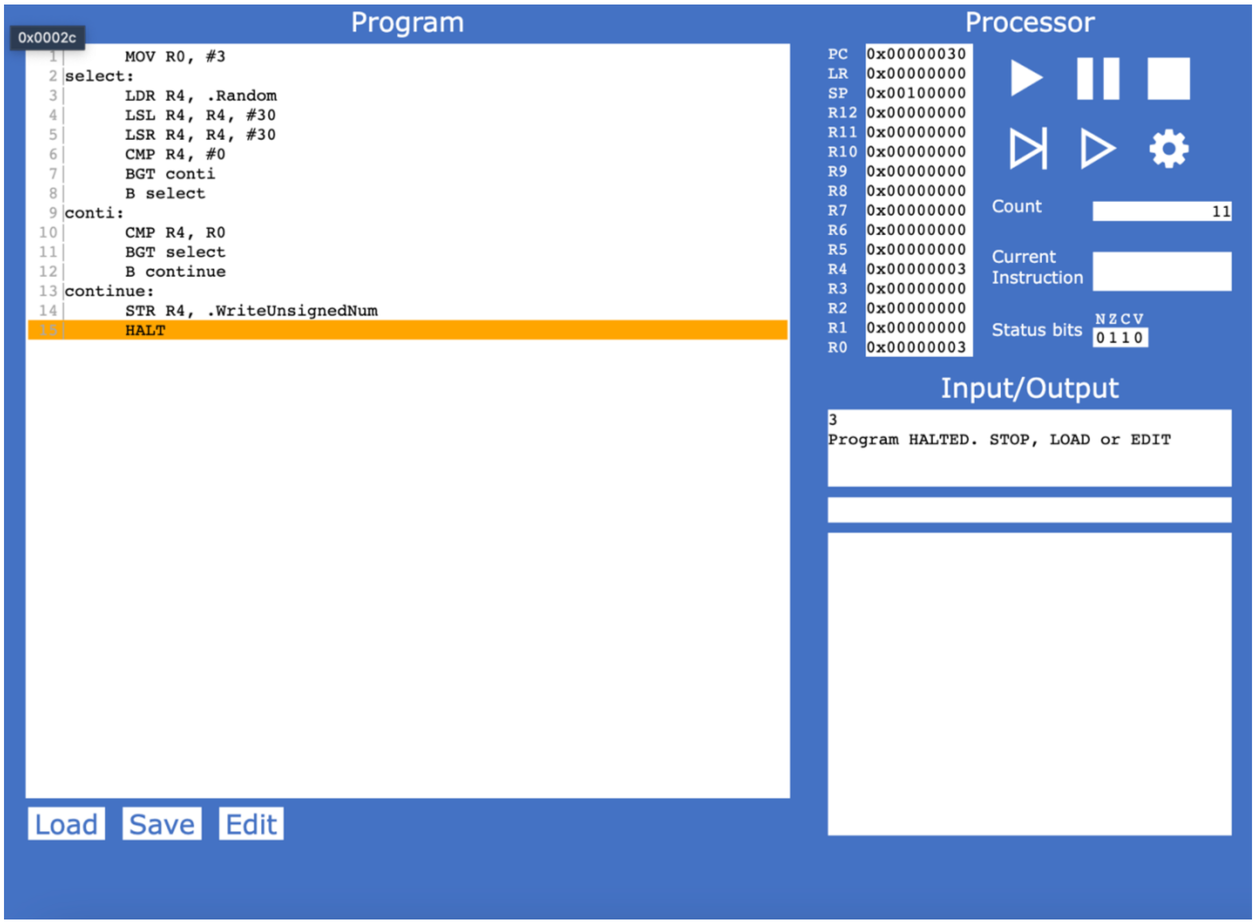
Status bits: N Z C V — 0 0 0 0

```
2
Program HALTED. STOP, LOAD or EDIT
```

8.3.2.

```
      MOV R0, #3
select:
      LDR R4, .Random
      LSL R4, R4, #30
      LSR R4, R4, #30
      CMP R4, #0
      BGT conti
      B select
conti:
      CMP R4, R0
      BGT select
      B continue
contInue:
      STR R4, .WriteUnsignedNum
```

HALT



```
        MOV R0, #3
select:
        LDR R4, .Random
        LSL R4, R4, #30
        LSR R4, R4, #30
        CMP R4, #0
        BGT conti
        B select
conti:
        CMP R4, R0
        BGT select
        B continue
continue:
        STR R4, .WriteUnsignedNum
        HALT
```

```
PC  0x00000030
LR  0x00000000
SP  0x00100000
R12 0x00000000
R11 0x00000000
R10 0x00000000
R9  0x00000000
R8  0x00000000
R7  0x00000000
R6  0x00000000
R5  0x00000000
R4  0x00000003
R3  0x00000000
R2  0x00000000
R1  0x00000000
R0  0x00000003

Count 11
Status bits NZCV 0110
```

```
3
Program HALTED. STOP, LOAD or EDIT
```

8.4.1.

```
        MOV R0, #15
        STR R0, .WriteUnsignedNum
        MOV R1, #msg1
        STR R1, .WriteString
Loop:
        MOV R1, #msg2
        STR R1, .WriteString
        LDR R2, .InputNum
start:
        CMP R2, #0
        BGT else1       // if R2 > 0 then jump to label else1
        B invalid1
else1:
        CMP R2, #4
        BGT invalid1      // if R2 > 3 then jump to label invalid1
        BLT cont          // if R2 < 4 then jump to label cont
invalid1:
        MOV R1, #msg3
        STR R1, .WriteString
        B start
cont1:
        CMP R0, R2
        BLT invalid1
        B cont2
cont2:
        SUB R0, R0, R2
        STR R0, .WriteUnsignedNum
        MOV R1, #msg1
        STR R1, .WriteString
        MOV R1, #msg5
        STR R1, .WriteString
        B select
select:
        LDR R4, .Random
        LSL R4, R4, #30
        LSR R4, R4, #30
        CMP R4, #0
        BGT conti
        B select
conti:
        CMP R4, R0
        BGT select
        B continue
continue:
        SUB R0, R0, R4
        STR R0, .WriteUnsignedNum
        MOV R1, #msg1
        STR R1, .WriteString
        MOV R1, #msg4
        STR R1, .WriteString
        B Loop
        HALT
msg1: .ASCIZ "remaining\n"
msg2: .ASCIZ "How many do you want to remove (1-3)?\n"
msg3: .ASCIZ "Please input a valid number!\n"
msg4: .ASCIZ "It's your turn!\n"
msg5: .ASCIZ "It's computer's turn!\n"

select:
        LDR R4, .Random
        LSL R4, R4, #30
        LSR R4, R4, #30
        CMP R4, #0
        BGT conti
        B select
conti:
        CMP R4, R0
        BGT select
        B continue
//

        SUB R0, R0, R4
        STR R0, .WriteUnsignedNum
        MOV R1, #msg1
        STR R1, .WriteString
```