Computer Organisation

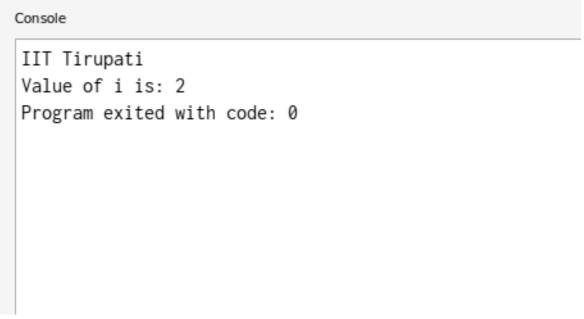
Name: Johri Aniket Manish
Roll.no: CS22B028
IIT Tirupati

Lab: 02

This report answers the observation, explanation and runtime of problem set sequentially.

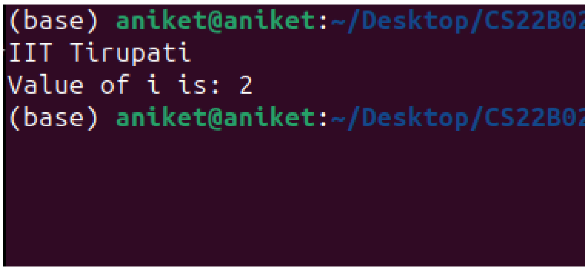
1. *Implement the below C code in Ripes.*

```
.data
    array: .word 0x0003 0x0003 0x0004 0x0003
    base: .word 0x10000000
    str1: .string "IIT Tirupati \n"
    str2: .string "Value of i is: "


.text
    .globl main

main:
    addi x3 x0 3      #x3 is k
    addi x4 x0 0      #x4 is i
    lw x11 base       #array first element

loop:
    lw x12 0(x11)
    bne x12 x3 exit
    addi x4 x0 2
    addi x11 x0 8
    j loop

exit:
    li a7 4
    la a0 str1
    ecall
    la a0 str2
    ecall
    li a7 1
    add a0 x0 x4
    ecall
```



```
IIT Tirupati
Value of i is: 2
Program exited with code: 0
```

(a) Output in Ripes Console



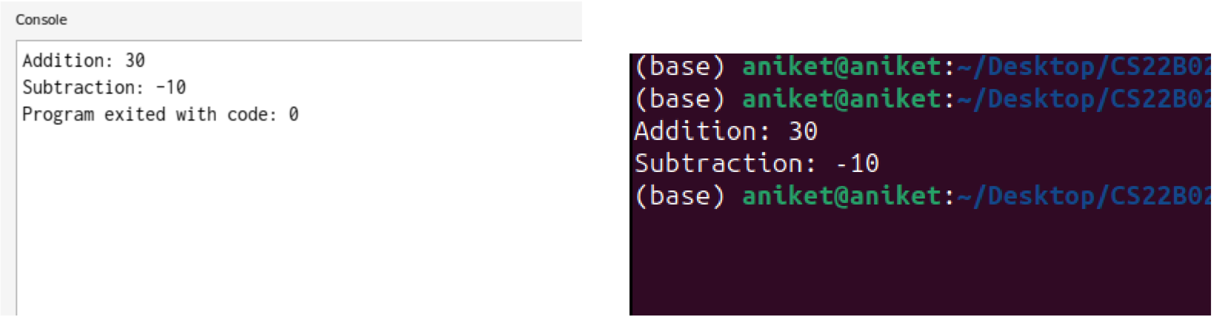
```
(base) aniket@aniket:~/Desktop/CS22B02
IIT Tirupati
Value of i is: 2
(base) aniket@aniket:~/Desktop/CS22B02
```

(b) Output in Terminal

Figure 1: Output

2. *Implement the below C code in Ripes.*

```
.data
    prompt1: .string "Addition: "
    prompt2: .string "\nSubtraction: "
    buffer:  .zero 255

.text
    .globl main

main:
    addi x1 zero 10
    addi x2 zero 20
    jal x3 addition
    jal x4 subtraction
    call print

    #exit program
    li a7 10
    ecall

addition:
    add x5 x1 x2
    jr x3

subtraction:
    sub x6 x1 x2
    jr x4

print:
    li a7 4
    la a0 prompt1
    ecall
    li a7 1
    mv a0 t0
    ecall
    li a7 4
    la a0 prompt2
    ecall
    li a7 1
    mv a0 t1
    ecall
    ret
```



```
Addition: 30
Subtraction: -10
Program exited with code: 0
```

```
(base) aniket@aniket:~/Desktop/CS22B02
(base) aniket@aniket:~/Desktop/CS22B02
Addition: 30
Subtraction: -10
(base) aniket@aniket:~/Desktop/CS22B02
```

(a) Output in Ripes Console

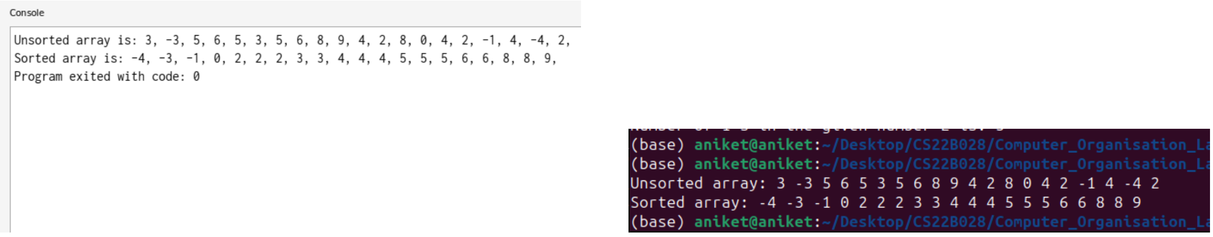
(b) Output in Terminal

Figure 2: Output

3. *The code shows how to load values into the memory and access them. Similarly load 20 values and implement bubble sort and print the sorted array on the console.*

```
.data
    array: .word 3,-3,5,6,5,3,5,6,8,9,4,2,8,0,4,2,-1,4,-4,2
    array_size: .word 20
    base: .word 0x10000000
    newline: .string "\n"
    delimiter: .string ", "
    prompt1: .string "Unsorted array is: "
    prompt2: .string "Sorted array is: "
    buffer: .zero 255

.text
    .globl main

main:
    li a7 4
    la a0 prompt1
    ecall
    la a0 array
    lw a1 array_size
    jal printArray

    jal printNewline

    #sort array using bubble sort
    la a0 array
    lw a1 array_size
    jal bubbleSort

    #print sorted array
    la a0 prompt2
    li a7 4
    ecall
    la a0 array
    lw a1 array_size
    jal printArray

    #end the program
    li a7 10
    ecall

printArray:
    mv t0 a0
    mv t1 a1
    loop:
        li a7 1
        lw a0 0(t0)
        ecall
        li a7 4
        la a0 delimiter
        ecall
        addi t0 t0 4
        addi t1 t1 -1
        bnez t1 loop
        ret


```

```
bubbleSort:
    mv t0 a0
    mv t1 a1
    addi t1 t1 -1
    li t2 1

    outer_loop:
        li t2 0
        li t3 0
        mv t0 a0
        inner_loop:
            beq t3 t1 end_inner_loop
            lw t4 0(t0)
            lw t5 4(t0)
            ble t4 t5 no_swap
            sw t5 0(t0)
            sw t4 4(t0)
            lw t4 0(t0)         #tocheck for debugging
            lw t5 4(t0)         #tocheck for debugging
            li t2 1
            no_swap:
                addi t0 t0 4
                addi t3 t3 1
                j inner_loop
        end_inner_loop:
        addi t1 t1 -1 #decrease the number of iterations each time
        bnez t2 outer_loop
        ret

printNewline:
    la a0, newline
    li a7, 4
    ecall
    jr x1
```



```
Unsorted array is: 3, -3, 5, 6, 5, 3, 5, 6, 8, 9, 4, 2, 8, 0, 4, 2, -1, 4, -4, 2,
Sorted array is: -4, -3, -1, 0, 2, 2, 2, 3, 3, 4, 4, 4, 5, 5, 5, 6, 6, 8, 8, 9,
Program exited with code: 0
```

(a) Output in Ripes Console

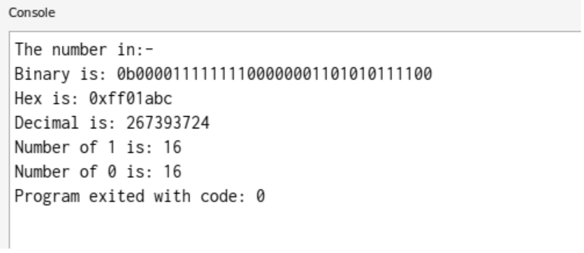
```
(base) aniket@aniket:~/Desktop/CS22B028/Computer_Organisation_La
(base) aniket@aniket:~/Desktop/CS22B028/Computer_Organisation_La
Unsorted array: 3 -3 5 6 5 3 5 6 8 9 4 2 8 0 4 2 -1 4 -4 2
Sorted array: -4 -3 -1 0 2 2 2 3 3 4 4 4 5 5 5 6 6 8 8 9
(base) aniket@aniket:~/Desktop/CS22B028/Computer_Organisation_La
```

(b) Output in Terminal

Figure 3: Output

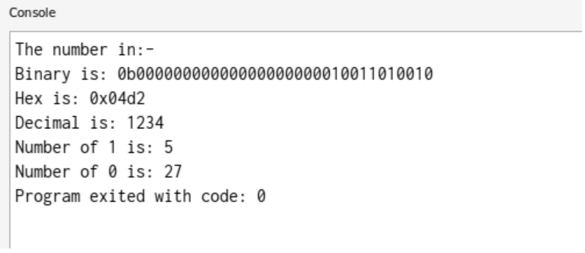
4. *Write a program to count the number of ones and zeros in a given 32-bit number. The program should print the number of ones and zeros on the console. Assume the number is stored in register x10.*

```
.data
    input: .word 0xff01abc
    prompt1: .string "The number in:-"
    prompt2: .string "\nBinary is: "
    prompt3: .string "\nHex is: "
    prompt4: .string "\nDecimal is: "
    prompt5: .string "\nNumber of 1 is: "
    prompt6: .string "\nNumber of 0 is: "
    buffer: .zero 32

.text
    .globl main

main:
    lw a0 input
    jal x1 print

    li t0 0            #count number of 1s
    li tp 0            #count number of 0s
    li t1 32           #number of bits to check
    jal x2 loop

print:
    li a7 4
    la a0 prompt1
    ecall
    la a0 prompt2
    ecall
    li a7 35
    lw a0 input
    ecall
    li a7 4
    la a0 prompt3
    ecall
    li a7 34
    lw a0 input
    ecall
    li a7 4
    la a0 prompt4
    ecall
    li a7 36
    lw a0 input
    ecall
    jr x1


loop:
    beqz t1 exit     #exit loop when 32--==0
    andi t2 a0 1     #do and operation to check if current bit is 1
    beqz t2 skip     #skip if bit is 0
    addi t0 t0 1     #else increment counter

skip:
    srli a0 a0 1       #shift right by 1
    addi t1 t1 -1       #decrement iterator
    j loop              #jump to loop back

exit:
    li a0 32
    sub tp a0 t0
    li a7 4
    la a0 prompt5
    ecall

    li a7 1
    mv a0 t0
    ecall

    li a7 4
    la a0 prompt6
    ecall

    li a7 1
    mv a0 tp
    ecall
    #end the program
    li a7, 10
    ecall
```



```
The number in:-
Binary is: 0b00001111111100000001101010111100
Hex is: 0xff01abc
Decimal is: 267393724
Number of 1 is: 16
Number of 0 is: 16
Program exited with code: 0
```

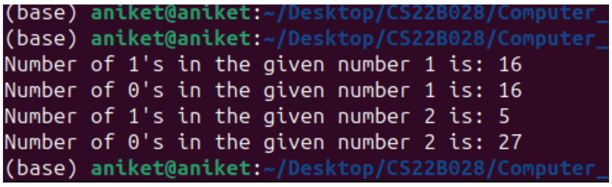
(a) Output in Ripes Console



```
The number in:-
Binary is: 0b00000000000000000000010011010010
Hex is: 0x04d2
Decimal is: 1234
Number of 1 is: 5
Number of 0 is: 27
Program exited with code: 0
```

(b) Output in Ripes Console

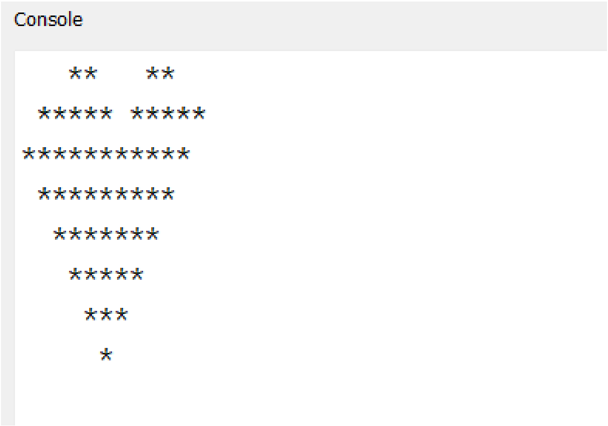
Figure 4: Output



```
(base) aniket@aniket:~/Desktop/CS22B028/Computer_
(base) aniket@aniket:~/Desktop/CS22B028/Computer_
Number of 1's in the given number 1 is: 16
Number of 0's in the given number 1 is: 16
Number of 1's in the given number 2 is: 5
Number of 0's in the given number 2 is: 27
(base) aniket@aniket:~/Desktop/CS22B028/Computer_
```

Figure 5: Output in Terminal

5. ♡*Happy Valentine's Day!* ♡



```
   **   **
 ***** *****
***********
 *********
  *******
   *****
    ***
     *
```

Figure 6: ♡Happy Valentine's Day! ♡