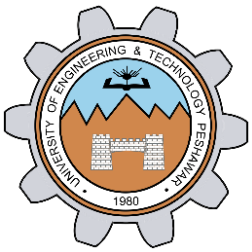
# IMPLEMENTATION OF PRIME NUMBERS IN MIPS

## LAB # 05




**Fall 2023**

**CSE-304L**

**Computer Organization & Architecture Lab**

Submitted by: **AIMAL KHAN**

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Class Section: **A**

"On my honor, as student of University of Engineering and Technology, I have neither given nor received unauthorized assistance on this academic work."

Student Signature: 

Submitted to:

**Dr. Bilal Habib**

Thursday, November 2, 2023

Department of Computer Systems Engineering

University of Engineering and Technology, Peshawar

## ASSESSMENT RUBRICS COA LABS

| LAB REPORT ASSESSMENT | | | | |
|---|---|---|---|---|
| **Criteria** | **Excellent** | **Average** | **Nill** | **Marks Obtained** |
| **1. Objectives of Lab** | All objectives of lab are properly covered [Marks 10] | Objectives of lab are partially covered [Marks 5] | Objectives of lab are not shown [Marks 0] | |
| **2. MIPS instructions with Comments and proper indentations.** | All the instructions are well written with comments explaining the code and properly indented [Marks 20] | Some instructions are missing are poorly commented code [Marks 10] | The instructions are not properly written [Marks 0] | |
| **3. Simulation run without error and warnings** | The code is running in the simulator without any error and warnings [Marks 10] | The code is running but with some warnings or errors. [Marks 5] | The code is written but not running due to errors [Marks 0] | |
| **4. Procedure** | All the instructions are written with proper procedure [Marks 20] | Some steps are missing [Marks 10] | steps are totally missing [Marks 0] | |
| **5. OUTPUT** | Proper output of the code written in assembly [Marks 20] | Some of the outputs are missing [Marks 10] | No or wrong output [Marks 0] | |
| **6. Conclusion** | Conclusion about the lab is shown and written [Marks 20] | Conclusion about the lab is partially shown [Marks 10] | Conclusion about the lab is not shown [Marks0] [Marks 0] | |
| **7. Cheating** | | | Any kind of cheating will lead to 0 Marks | |
| Total Marks Obtained: _____<br>Instructor Signature: _____ | | | | |

# Implementation of Prime Numbers in MIPS

## Objectives:

- To apply the learned MIPS commands and concepts to implement a logic for checking whether a number is prime or not.
- To extend the implementation to find and display the two largest prime numbers lower than a user-input number.
- To develop a program that takes two user-input limits and displays prime numbers within the specified range.

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## Tasks:

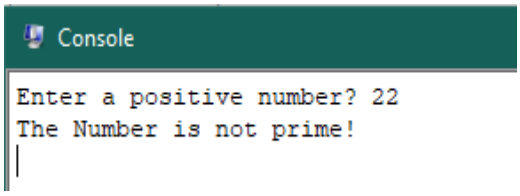
**Task 1**: Write a program to check whether a number input by user is prime or not.

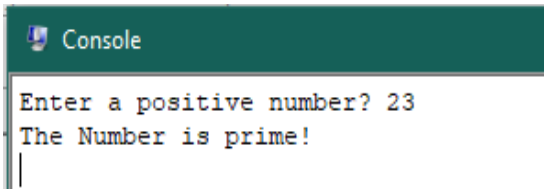
**Code:**

```
.text
.globl main

main:
    # show the prompt
    li $v0, 4
    la $a0, prompt
    syscall

    # take the number $t0=n from user
    li $v0, 5
    syscall
    move $t0, $v0

    # implementation of isPrime function
    isPrime:
        li $t1, 2

        blt $t0, $t1, notPrimeNumberLabel

        # calculate $t3 = n/2
        div $t0, $t1
        mflo $t3

        # loop from 2 to n/2
        loop:
            div $t0, $t1
            mfhi $t4

            beq $t4, $zero, notPrimeNumberLabel

            addi $t1, $t1, 1 # increment the index
```

```
            ble $t1, $t3, loop # check to continue the loop
        j isPrimeNumberLabel

        notPrimeNumberLabel:
            # show that number is not prime
            li $v0, 4
            la $a0, notPrimeNumberMsg
            syscall

            j Exit

        isPrimeNumberLabel:
            # show that number is prime
            li $v0, 4
            la $a0, isPrimeNumberMsg
            syscall

            j Exit

    Exit:
        li $v0, 10
        syscall


.data
    prompt: .asciiz "Enter a positive number? "
    notPrimeNumberMsg: .asciiz "The Number is not prime!\n"
    isPrimeNumberMsg: .asciiz "The Number is prime!\n"
```

**Output:**




**Task 2**: Repeat the above problem and display the largest two prime numbers lower than itself. Hint: If a user enters 20, then program displays 19 and 17.

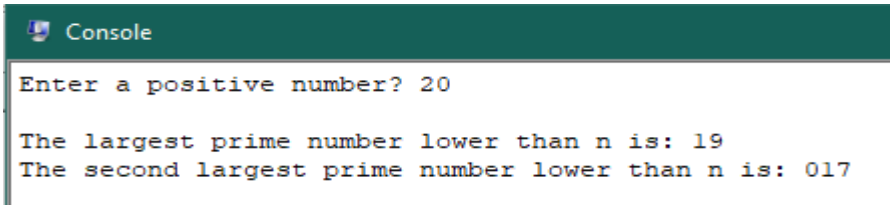
**Code:**

```
.text
.globl main

main:
    # Show the prompt
    li $v0, 4
    la $a0, prompt
    syscall

    # Take the number $t0=n from the user
    li $v0, 5
```

```
    syscall
    move $t0, $v0

    # Initialize $t5 to 2 for the isPrime function
    li $t5, 2
    # Find the largest two prime numbers lower than n
    find_primes:
        addi $t0, $t0, -1

    # Check if $t0 is less than 2 (end of search)
    blez $t0, exit
        # Call isPrime function with $t0 as the argument
        move $a0, $t0
        jal isPrime

        # Check if $v0 (result from isPrime) is 1 (prime)
        beq $v0, $zero, find_primes

        # If $v0 is 1, we found a prime, store it in $t1 and check
for the second prime
        move $t1, $t0  # Store the first prime in $t1
        addi $t0, $t0, -1  # Decrement n by 1 to continue searching
        # Call isPrime function with $t0 as the argument
        move $a0, $t0
        jal isPrime

        # Check if $v0 (result from isPrime) is 1 (prime)
        beq $v0, $zero, exit  # If not prime, exit

        # If $v0 is 1, we found the second prime, store it in $t2
and exit
        move $t2, $t0
        j exit

    # isPrime function
    isPrime:
        li $t3, 2  # Initialize $t3 to 2

        # Check if n < 2
        blt $a0, $t3, notPrimeNumber

        # Calculate n/2 and store it in $t4
        div $a0, $t3
        mflo $t4

        # Loop from 2 to n/2
        isPrimeLoop:
            div $a0, $t3
            mfhi $t6
            beq $t6, $zero, notPrimeNumber
            addi $t3, $t3, 1  # Increment the index
            ble $t3, $t4, isPrimeLoop  # Check to continue the loop

        # Number is prime, set $v0 to 1
```

```
        li $v0, 1
        j isPrimeExit

    notPrimeNumber:
        # Number is not prime, set $v0 to 0
        li $v0, 0

    isPrimeExit:
        jr $ra  # Return to the caller

    exit:
        # Display the largest two prime numbers
        li $v0, 4
        la $a0, primeResult1
        syscall

        li $v0, 1
        move $a0, $t1
        syscall

        li $v0, 4
        la $a0, primeResult2
        syscall

        li $v0, 1
        move $a0, $t2
        syscall

        # Exit the program
        li $v0, 10
        syscall

.data
    prompt: .asciiz "Enter a positive number? "
    primeResult1: .asciiz "\nThe largest prime number lower than n
is: "
    primeResult2: .asciiz "\nThe second largest prime number lower
than n is: "
```

**Output:**




**Task 3**: Write a program which takes two limits from user and display prime numbers between the two limits (if user enter lower limit 10 and upper limit 30 then display prime numbers between 10 and 30)

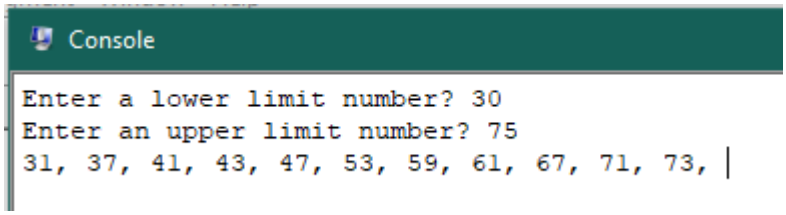
**Code:**

```
.text
.globl main
```

```
main:
    # show the prompt for lower number
    li $v0, 4
    la $a0, prompt1
    syscall

    # take the number $t0=n1 from user
    li $v0, 5
    syscall
    move $t0, $v0

    # show the prompt for upper number
    li $v0, 4
    la $a0, prompt2
    syscall

    # take the number $t1=n2 from user
    li $v0, 5
    syscall
    move $t1, $v0

    # taking loop from n1 to n2
    loopFromLower2Upper:
        bgt $t0, $t1, Exit
        j isPrime

    # implementation of isPrime function
    isPrime:
        li $t2, 2

        blt $t0, $t2, notPrimeNumberLabel

        # calculate $t3 = n/2
        div $t0, $t2
        mflo $t3

        # loop from 2 to n/2
        loop:
            div $t0, $t2
            mfhi $t4

            beq $t4, $zero, notPrimeNumberLabel

            addi $t2, $t2, 1 # increment the index

            ble $t2, $t3, loop # check to continue the loop
        j isPrimeNumberLabel

        notPrimeNumberLabel:
            # only increment the loop
            addi $t0, $t0, 1

            j loopFromLower2Upper
```

```
        isPrimeNumberLabel:
            # show that number is prime
            li $v0, 1
            move $a0, $t0
            syscall

            li $v0, 4
            la $a0, comma
            syscall

            addi $t0, $t0, 1

            j loopFromLower2Upper

    Exit:
        li $v0, 10
        syscall

.data
    prompt1: .asciiz "Enter a lower limit number? "
    prompt2: .asciiz "Enter an upper limit number? "
    comma: .asciiz ", "
```

**Output:**

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## Reference:

To view my codes, please refer to my GitHub Account.

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## Conclusion:

This lab has provided me with a practical opportunity to apply my knowledge of MIPS assembly language to solve real-world mathematical problems, enhancing my understanding of computer organization and architecture (COA). It has also reinforced my skills in algorithmic thinking and problem-solving, which are essential in the field of computer science and engineering.

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The End.