Operating Systems LAB

PAPER CODE	**:**	**CIC-353**
Faculty Name	:	Ms. Kavita Saxena
Name	:	Amit Singhal
Enrollment No.	:	11614802722
Branch	:	Computer Science & Engg.
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MAHARAJA AGRASEN INSTITUTE OF TECHNOLOGY

PSP Area, Plot No. 1, Sector-22, Rohini, Delhi-110086

MAHARAJA AGRASEN INSTITUTE OF TECHNOLOGY

Computer Science & Engineering Department

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LAB Assessment Sheet

S.No.	Experiment Name	M	A	R	K	S	Total Marks	Date of Perf.	Date of Check.	Signature
		R1	R2	R3	R4	R5				

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		R1	R2	R3	R4	R5				

Lab Exercise - 1

❖ AIM :: Introduction to Linux & vi-Editor

1. Introduction to Linux

- **What is Linux?**: Linux is a powerful and versatile open-source operating system based on the Unix architecture. It was created by Linus Torvalds in 1991 and has since grown into a widely-used platform for both personal and professional computing.
- **Open Source Nature**: One of the defining characteristics of Linux is that its source code is freely available for anyone to view, modify, and distribute. This has led to a collaborative environment where developers worldwide contribute to its development.
- **Kernel and Distributions**: Linux is composed of a kernel, which is the core component of the OS, and various distributions (distros) that bundle the kernel with software and package management systems. Popular distributions include Ubuntu, Fedora, Debian, and CentOS.
- **Linux in Different Environments**: Linux is used in a variety of environments, including desktops, servers, mobile devices, and embedded systems. Its flexibility allows it to run on a wide range of hardware, from supercomputers to small IoT devices.

2. Overview of the `vi` Editor

The `vi` (Visual Editor) is a powerful text editor available on almost all Unix-like operating systems, including Linux. It's known for its efficiency and versatility, particularly in environments where only a terminal interface is available. Here is a detailed look at the `vi` editor and its commands, presented in informative points.

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1. Basics of `vi` Editor

- **Launching** `vi`: To start `vi`, type `vi filename` in the terminal. If `filename` does not exist, `vi` will create it.
- **Modes in** `vi`:
  - **Normal Mode**: The default mode where you can navigate and manipulate text.
  - **Insert Mode**: Used for inserting text. Enter by pressing `i`, `a`, or `o`.
  - **Command Mode**: Enter by typing `:` in Normal Mode for commands like saving, quitting, etc.
  - **Visual Mode**: Used to highlight and manipulate blocks of text.

2. Basic Commands for Running a C File

To work with C files in the `vi` editor, you only need a few basic commands to edit, save, and compile the file. Here's a simplified guide:

- **Open a File**: `vi filename.c`
  - Launches `vi` and opens the file named `filename.c`. If it doesn't exist, `vi` will create it.
- **Insert Mode**:
  - `i`: Enter Insert Mode before the cursor position.
  - `I`: Enter Insert Mode at the beginning of the line.
  - `a`: Enter Insert Mode after the cursor position.
  - `A`: Enter Insert Mode at the end of the line.
  - `o`: Open a new line below the current line and enter Insert Mode.
  - `O`: Open a new line above the current line and enter Insert Mode.
- **Save and Exit**:
  - `:w`: Save the file without exiting.
  - `:w filename`: Save the file with a new name.
  - `:q`: Quit `vi` without saving.
  - `:wq` **or** `ZZ`: Save the file and quit `vi`.
  - `:q!`: Quit without saving changes.

Implementation

Writing and Running a basic "Hello, World!" program in C using the terminal on a Linux system.

```
1. cd ~/project

2. vi hello.c



/* Save and Exit vi:

    • Press Esc to exit Insert Mode.
    • Type :wq and press Enter to save the file and quit vi.

*/


3. gcc hello.c -o hello

4. ./hello
```

```
#include <stdio.h>

int main() {
    printf("Hello, World!\n");
    return 0;
}

~
~
~
~
:wq
```

```
amit@Toshiba-Satellite-C850:~$ cd Downloads/
amit@Toshiba-Satellite-C850:~/Downloads$ vi hello.c
amit@Toshiba-Satellite-C850:~/Downloads$ gcc hello.c -o hello
amit@Toshiba-Satellite-C850:~/Downloads$ ./hello
Hello, World!
amit@Toshiba-Satellite-C850:~/Downloads$
```

Lab Exercise - 2

- AIM :: WAP in C to implement basic operations in different functions on Linux using vi-Editor

Source_Code ::

```
#include <stdio.h>
// Function to find the greatest number among three numbers
int findGreatest(int a, int b, int c)
{
   if (a > b && a > c) {
      return a;
   } else if (b > c) {
      return b;
   } else {
      return c;
   }
}
// Function to check if a number is even or odd
void evenOdd(int num)
{
   if (num % 2 == 0) {
      printf("%d is Even\n", num);
   } else {
      printf("%d is Odd\n", num);
   }
}
```

```
// Function to check if a number is prime
void checkPrime(int num)
{
    int i, flag = 0;
    if (num <= 1) {
        printf("%d is not a Prime number\n", num);
        return;
    }
    for (i = 2; i <= num / 2; ++i) {
        if (num % i == 0) {
            flag = 1;
            break;
        }
    }
    if (flag == 0) {
        printf("%d is a Prime number\n", num);
    } else {
        printf("%d is not a Prime number\n", num);
    }
}
// Function to calculate the average of three numbers
double calculateAverage(int a, int b, int c) { return (a + b + c) / 3.0; }
int main()
{
    printf("\n5C6 - Amit Singhal (11614802722)\n");
    int num1, num2, num3;
    int choice;
    printf("\nChoose an operation:\n");
    printf("1. Find Greatest of Three Numbers\n");
    printf("2. Check Even or Odd\n");
```

```
printf("3. Check Prime Number\n");
printf("4. Calculate Average of Three Numbers\n");
printf("5. Exit\n");
while (1) {
    printf("\nEnter your choice: ");
    scanf("%d", &choice);
    switch (choice) {
    case 1:
        printf("\nEnter three numbers: ");
        scanf("%d %d %d", &num1, &num2, &num3);
        printf("Greatest Number: %d\n", findGreatest(num1, num2, num3));
        break;
    case 2:
        printf("\nEnter a number: ");
        scanf("%d", &num1);
        evenOdd(num1);
        break;
    case 3:
        printf("\nEnter a number: ");
        scanf("%d", &num1);
        checkPrime(num1);
        break;
    case 4:
        printf("\nEnter three numbers: ");
        scanf("%d %d %d", &num1, &num2, &num3);
        printf("Average: %.2f\n", calculateAverage(num1, num2, num3));
        break;
    case 5:
        printf("\n");
        return 0;
    default:
```

```
        printf("\nInvalid choice! Please choose again.\n");
    }
  }
  return 0;
}
```

Output ::

```
amit@Toshiba-Satellite-C850:~$ cd Desktop/Code/
amit@Toshiba-Satellite-C850:~/Desktop/Code$ vi basic_operations.c
amit@Toshiba-Satellite-C850:~/Desktop/Code$ gcc basic_operations.c -o basic_operations
amit@Toshiba-Satellite-C850:~/Desktop/Code$ ./basic_operations

5C6 - Amit Singhal (11614802722)

Choose an operation:
1. Find Greatest of Three Numbers
2. Check Even or Odd
3. Check Prime Number
4. Calculate Average of Three Numbers
5. Exit

Enter your choice: 1

Enter three numbers: 105 116 122
Greatest Number: 122

Enter your choice: 2

Enter a number: 13345
13345 is Odd

Enter your choice: 3

Enter a number: 5456527
5456527 is not a Prime number

Enter your choice: 4

Enter three numbers: 2234 4523 4355
Average: 3704.00

Enter your choice: 5

amit@Toshiba-Satellite-C850:~/Desktop/Code$
```

Lab Exercise – 2.2

- AIM :: WAP in C to implement basic operations in different functions on Linux using vi-Editor.

Source_Code ::

```
#include <stdbool.h>
#include <stdio.h>
#include <string.h>

// Function to print the Fibonacci series up to n terms
void fibonacci(int n)
{
   int first = 0, second = 1, next;

   if (n <= 0) {
      printf("Please enter a positive integer.\n");
      return;
   }

   printf("Fibonacci Series: ");
   for (int i = 1; i <= n; i++) {
      if (i == 1) {
         printf("%d ", first);
         continue;
      }
      if (i == 2) {
         printf("%d ", second);
```

```
            continue;
        }
        next = first + second;
        first = second;
        second = next;
        printf("%d ", next);
    }
    printf("\n");
}

// Function to calculate the factorial of a number
int factorial(int n)
{
    if (n == 0) {
        return 1;
    }
    return n * factorial(n - 1);
}

// Function to calculate the sum of digits of a number
int digitsSum(int num)
{
    int sum = 0;
    while (num != 0) {
        sum += num % 10;
        num /= 10;
    }
    return sum;
}

// Function to check if a string is a palindrome
bool isPalindrome(char str[])
```

```
{
    int length = strlen(str);
    int start = 0;
    int end = length - 1;

    while (start < end) {
        if (str[start] != str[end]) {
            return false;
        }
        start++;
        end--;
    }
    return true;
}

// Function to count the occurrences of a character in a string
int countChar(char* str, char ch)
{
    int count = 0;
    for (int i = 0; str[i] != '\0'; i++) {
        if (str[i] == ch) {
            count++;
        }
    }
    return count;
}

int main()
{

    int choice, num1, num2, num3;
    char str[100], ch;
```

```
printf("\n5C6 - Amit Singhal (11614802722)\n");

// Display the menu
printf("\nMenu:\n");
printf("1. Print Fibonacci Series\n");
printf("2. Calculate Factorial\n");
printf("3. Calculate Sum of Digits\n");
printf("4. Check Palindrome\n");
printf("5. Count Character Occurrences\n");
printf("6. Exit\n");

while (1) {
   printf("\nEnter your choice (1-6): ");
   scanf("%d", &choice);

   switch (choice) {

   case 1:
      printf("\nEnter the number of terms for Fibonacci series: ");
      scanf("%d", &num1);
      fibonacci(num1);
      break;
   case 2:
      printf("\nEnter a number to calculate its factorial: ");
      scanf("%d", &num1);
      printf("Factorial: %d\n", factorial(num1));
      break;
   case 3:
      printf("\nEnter a number to calculate the sum of its digits: ");
      scanf("%d", &num1);
      printf("Sum of Digits: %d\n", digitsSum(num1));
```

```
            break;
        case 4:
            printf("Enter a string to check if it is a palindrome: ");
            scanf("%s", str);

            if (isPalindrome(str)) {
                printf("%s is a Palindrome\n", str);
            } else {
                printf("%s is not a Palindrome\n", str);
            }
            break;
        case 5:
            printf("\nEnter a string: ");
            scanf("%s", str);
            printf("Enter a character to count its occurrences: ");
            scanf(" %c", &ch);
            printf("Count of '%c': %d\n", ch, countChar(str, ch));
            break;
        case 6:
            printf("\nExiting the program. Have a great day!\n");
            return 0;
        default:
            printf(
                "\nInvalid choice! Please select a number between 1 and 6.\n");
        }
    }

    return 0;
}
```

Output ::

```
amit@Toshiba-Satellite-C850:~/Downloads/OS$ vi basic_operations_2.c

amit@Toshiba-Satellite-C850:~/Downloads/OS$ gcc basic_operations_2.c -o prg_2

amit@Toshiba-Satellite-C850:~/Downloads/OS$ ./prg_2

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Menu:
1. Print Fibonacci Series
2. Calculate Factorial
3. Calculate Sum of Digits
4. Check Palindrome
5. Count Character Occurrences
6. Exit

Enter your choice (1-6): 1

Enter the number of terms for Fibonacci series: 9
Fibonacci Series: 0 1 1 2 3 5 8 13 21

Enter your choice (1-6): 12

Invalid choice! Please select a number between 1 and 6.
Enter your choice (1-6): 2

Enter a number to calculate its factorial: 12
Factorial: 479001600

Enter your choice (1-6): 3

Enter a number to calculate the sum of its digits: 35544355
Sum of Digits: 34

Enter your choice (1-6): 4
Enter a string to check if it is a palindrome: madam
madam is a Palindrome

Enter your choice (1-6): 5

Enter a string: helloworld
Enter a character to count its occurrences: l
Count of 'l': 3

Enter your choice (1-6): 6

Exiting the program. Have a great day!
amit@Toshiba-Satellite-C850:~/Downloads/OS$
```

Lab Exercise – 3

- AIM :: WAP in C to implement CPU scheduling for `first come first serve` (fcfs).

Source_Code ::

```
#include <stdio.h>

typedef struct
{
  int pid;        // Process ID
  int arrival;    // Arrival time
  int burst;      // Burst time
  int completion; // Completion time
  int waiting;    // Waiting time
  int turnaround; // Turnaround time
} Process;

// Function to sort processes by arrival time
void sortByArrival(Process *p, int n)
{
  for (int i = 0; i < n - 1; i++)
  {
    for (int j = 0; j < n - i - 1; j++)
    {
      if (p[j].arrival > p[j + 1].arrival)
```

```
      {
        Process temp = p[j];
        p[j] = p[j + 1];
        p[j + 1] = temp;
      }
    }
  }
}

// Main FCFS logic
void fcfsScheduling(Process *p, int n)
{
  int time = 0;

  for (int i = 0; i < n; i++)
  {
    if (time < p[i].arrival)
      time = p[i].arrival; // Set time to the process arrival time if idle

    time += p[i].burst;
    p[i].completion = time;
    p[i].turnaround = p[i].completion - p[i].arrival;
    p[i].waiting = p[i].turnaround - p[i].burst;
  }
}

// Function to display the Gantt chart with idle times
void displayGanttChart(Process *p, int n)
{
```

```
  int currentTime = p[0].arrival; // Start from the first process arrival time
  printf("Gantt Chart:\n");

  // Print initial time
  printf("%d", currentTime);

  for (int i = 0; i < n; i++)
  {
    if (currentTime < p[i].arrival)
    {
      // Display idle time
      printf(" -- XX -- %d", p[i].arrival);
      currentTime = p[i].arrival; // Update current time to the arrival of the next process
    }
    // Display the process and its completion time
    printf(" -- P%d -- %d", p[i].pid, p[i].completion);
    currentTime = p[i].completion; // Update current time to the completion of the current process
  }

  printf("\n\n");
}

// Function to calculate and display average times
void calculateAverages(Process *p, int n)
{
  float totalTurnaround = 0, totalWaiting = 0;

  for (int i = 0; i < n; i++)
```

```
  {
    totalTurnaround += p[i].turnaround;
    totalWaiting += p[i].waiting;
  }

  printf("\nAverage Turnaround Time: %.2f\n", totalTurnaround / n);
  printf("Average Waiting Time: %.2f\n", totalWaiting / n);
}

// Function to display process information
void displayResults(Process *p, int n) {
  printf("PID\tArrival\t Burst\t Completion\tTurnaround\tWaiting\n");
  for (int i = 0; i < n; i++) {
    printf("%d\t%d\t %d\t %d\t\t%d\t\t%d\n", p[i].pid, p[i].arrival, p[i].burst,
           p[i].completion, p[i].turnaround, p[i].waiting);
  }
}

int main() {
  int n;
  printf("\n5C6 - Amit Singhal (11614802722)\n");
  printf("\nEnter number of processes: ");
  scanf("%d", &n);
  Process p[n];

  for (int i = 0; i < n; i++) {
    printf("\nEnter Arrival Time and Burst Time for Process %d: ", i + 1);
    p[i].pid = i + 1;
    scanf("%d%d", &p[i].arrival, &p[i].burst);
```

```
    p[i].completion = 0; // Initially, no process is completed
  }
  printf("\n");

  sortByArrival(p, n);
  fcfsScheduling(p, n);
  displayGanttChart(p, n);
  displayResults(p, n);
  calculateAverages(p, n);

  printf("\n");

  return 0;
}
```

Output ::

```
singhal-amit@singhal-amit-ThinkPad-T430:~/Downloads/_LAB_Work/OS/Code$ vi prg_3_fcfs.c
singhal-amit@singhal-amit-ThinkPad-T430:~/Downloads/_LAB_Work/OS/Code$ gcc prg_3_fcfs.c
singhal-amit@singhal-amit-ThinkPad-T430:~/Downloads/_LAB_Work/OS/Code$ ./a.out

5C6 - Amit Singhal (11614802722)

Enter number of processes: 4

Enter Arrival Time and Burst Time for Process 1: 0 2

Enter Arrival Time and Burst Time for Process 2: 1 2

Enter Arrival Time and Burst Time for Process 3: 5 3

Enter Arrival Time and Burst Time for Process 4: 6 4

Gantt Chart:
0 -- P1 -- 2 -- P2 -- 4 -- XX -- 5 -- P3 -- 8 -- P4 -- 12

PID     Arrival  Burst   Completion     Turnaround      Waiting
1       0        2       2              2               0
2       1        2       4              3               1
3       5        3       8              3               0
4       6        4       12             6               2

Average Turnaround Time: 3.50
Average Waiting Time: 0.75
```

Lab Exercise – 4

- AIM :: WAP in C to implement CPU scheduling for `shortest job first` (sjf).

Source_Code ::

```
#include <stdio.h>


typedef struct
{
  int pid;        // Process ID
  int arrival;    // Arrival time
  int burst;      // Burst time
  int completion; // Completion time
  int waiting;    // Waiting time
  int turnaround; // Turnaround time
} Process;


// Function to sort processes by arrival time, and by burst time in case of tie
void sortByArrival(Process *p, int n)
{
  for (int i = 0; i < n - 1; i++)
  {
    for (int j = 0; j < n - i - 1; j++)
    {
```

```
      if (p[j].arrival > p[j + 1].arrival ||
          (p[j].arrival == p[j + 1].arrival && p[j].burst > p[j + 1].burst))
      {
        Process temp = p[j];
        p[j] = p[j + 1];
        p[j + 1] = temp;
      }
    }
  }
}

// Main SJF logic
void sjfScheduling(Process *p, int n)
{
  int time = 0, completed = 0, minIndex;

  while (completed < n)
  {
    minIndex = -1;

    // Find process with min burst time from the pool of arrived processes
    for (int i = 0; i < n; i++)
    {
      if (p[i].arrival <= time && p[i].completion == 0)
      {
        if (minIndex == -1 || p[i].burst < p[minIndex].burst)
```

```
        {
          minIndex = i;
        }
      }
    }

    if (minIndex != -1)
    {
      if (time < p[minIndex].arrival)
        time = p[minIndex].arrival; // Set time to the process arrival time if idle

      time += p[minIndex].burst;
      p[minIndex].completion = time;
      p[minIndex].turnaround = p[minIndex].completion - p[minIndex].arrival;
      p[minIndex].waiting = p[minIndex].turnaround - p[minIndex].burst;
      completed++;
    }
    else
    {
      time++;
    }
  }
}

// Function to display the Gantt chart
void displayGanttChart(Process *p, int n)
```

```
{
  int startTime = p[0].arrival;
  printf("Gantt Chart:\n%d", startTime);

  for (int i = 0; i < n; i++)
  {
    printf(" -- P%d -- %d", p[i].pid, p[i].completion);
  }

  printf("\n\n");
}

// Function to calculate and display average times
void calculateAverages(Process *p, int n)
{
  float totalTurnaround = 0, totalWaiting = 0;

  for (int i = 0; i < n; i++)
  {
    totalTurnaround += p[i].turnaround;
    totalWaiting += p[i].waiting;
  }

  printf("\nAverage Turnaround Time: %.2f\n", totalTurnaround / n);
  printf("Average Waiting Time: %.2f\n", totalWaiting / n);
}
```

```
// Function to display process information
void displayResults(Process *p, int n)
{
  printf("PID\tArrival\t Burst\t Completion\tTurnaround\tWaiting\n");
  for (int i = 0; i < n; i++)
  {
    printf("%d\t%d\t %d\t %d\t\t%d\t\t%d\n", p[i].pid, p[i].arrival, p[i].burst,
          p[i].completion, p[i].turnaround, p[i].waiting);
  }
}

int main()
{
  int n;
  printf("\n5C6 - Amit Singhal (11614802722)\n");
  printf("\nEnter number of processes: ");
  scanf("%d", &n);
  Process p[n];

  for (int i = 0; i < n; i++) {
    printf("\nEnter Arrival Time and Burst Time for Process %d: ", i + 1);
    p[i].pid = i + 1;
    scanf("%d%d", &p[i].arrival, &p[i].burst);
    p[i].completion = 0; // Initially, no process is completed
  }
```

```
    printf("\n");

    sortByArrival(p, n);
    sjfScheduling(p, n);
    displayGanttChart(p, n);
    displayResults(p, n);
    calculateAverages(p, n);

    printf("\n");

    return 0;
}
```

Output ::

```
singhal-amit@singhal-amit-ThinkPad-T430:~/Downloads/_LAB_Work/OS/Code$ vi prg_4_sjf.c
singhal-amit@singhal-amit-ThinkPad-T430:~/Downloads/_LAB_Work/OS/Code$ gcc prg_4_sjf.c
singhal-amit@singhal-amit-ThinkPad-T430:~/Downloads/_LAB_Work/OS/Code$ ./a.out

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Enter number of processes: 4

Enter Arrival Time and Burst Time for Process 1: 1 3

Enter Arrival Time and Burst Time for Process 2: 2 4

Enter Arrival Time and Burst Time for Process 3: 1 2

Enter Arrival Time and Burst Time for Process 4: 4 4

Gantt Chart:
1 -- P3 -- 3 -- P1 -- 6 -- P2 -- 10 -- P4 -- 14

PID     Arrival  Burst   Completion     Turnaround      Waiting
3       1        2       3              2               0
1       1        3       6              5               2
2       2        4       10             8               4
4       4        4       14             10              6

Average Turnaround Time: 6.25
Average Waiting Time: 3.00
```

Lab Exercise – 5

- AIM :: WAP in shell script to implement CPU scheduling for `first come first serve` (fcfs).

Source_Code ::

```
echo $'\n' "5C6 - Amit Singhal (11614802722)" $'\n'

read -p "Enter the number of processes: " num_processes
echo $'\n' "Enter Arrival Time & Burst Time for $num_processes processes"

# Collect process details
for ((i=0;i<num_processes;i++)); do
    echo -n "P$((i+1)): "
    read arrival_time burst_time
    processes[$i]="$arrival_time $burst_time"
done

# Sort processes by arrival time
IFS=$'\n' sorted_processes=($(sort -n -k1 <<<"${processes[*]}"))
unset IFS

# Initialize variables
total_completion_time=0
total_waiting_time=0
total_turnaround_time=0
gantt_chart="0"  # Start Gantt chart at time 0

# Display table header
```

```
echo -e "\nProcess    Arrival Time    Burst Time    Completion Time    TurnAround Time    Waiting Time"

# Process all processes
for ((i=0;i<num_processes;i++)); do
    current_process=(${sorted_processes[$i]})
    current_arrival_time=${current_process[0]}
    current_burst_time=${current_process[1]}

    # If the process arrives after the last completion time, idle CPU
    if (( total_completion_time < current_arrival_time )); then
        idle_time=$((current_arrival_time - total_completion_time))
        total_completion_time=$current_arrival_time
        gantt_chart+=" -- XX -- $total_completion_time"
    fi

    # Calculate waiting time
    if (( total_completion_time >= current_arrival_time )); then
        waiting_time=$((total_completion_time - current_arrival_time))
    else
        waiting_time=0
    fi

    # Calculate completion time and turnaround time
    completion_time=$((total_completion_time + current_burst_time))
    turnaround_time=$((completion_time - current_arrival_time))

    # Update total values
    total_completion_time=$completion_time
    total_waiting_time=$((total_waiting_time + waiting_time))
    total_turnaround_time=$((total_turnaround_time + turnaround_time))

    # Display process details
    echo -e "P$((i+1))\t\t$current_arrival_time\t\t$current_burst_time\t\t$completion_time\t\t  $turnaround_time\t\t  $waiting_time"
```

```
    # Update Gantt chart
    gantt_chart+=" -- P$((i+1)) -- $completion_time"
done

# Calculate averages
avg_waiting_time=$(awk "BEGIN {printf \"%.2f\", $total_waiting_time/$num_processes}")
avg_turnaround_time=$(awk "BEGIN {printf \"%.2f\", $total_turnaround_time/$num_processes}")

# Display Gantt chart
echo -e "\nGantt Chart:"
echo -e "$gantt_chart"

# Display averages
echo ""
echo "Avg waiting time: $avg_waiting_time"
echo "Avg turnaround time: $avg_turnaround_time"
```

Output ::

```
singhal-amit@singhal-amit-ThinkPad-T430:~/Downloads/_LAB_Work/OS/Code$ vi prg_5_fcfs.sh
singhal-amit@singhal-amit-ThinkPad-T430:~/Downloads/_LAB_Work/OS/Code$ chmod +x prg_5_fcfs.sh
singhal-amit@singhal-amit-ThinkPad-T430:~/Downloads/_LAB_Work/OS/Code$ ./prg_5_fcfs.sh

 5C6 - Amit Singhal (11614802722)

Enter the number of processes: 4

 Enter Arrival Time & Burst Time for 4 processes
P1: 0 2
P2: 1 2
P3: 5 3
P4: 6 4

Process    Arrival Time    Burst Time    Completion Time    TurnAround Time    Waiting Time
P1              0               2               2                2               0
P2              1               2               4                3               1
P3              5               3               8                3               0
P4              6               4               12               6               2

Gantt Chart:
0 -- P1 -- 2 -- P2 -- 4 -- XX -- 5 -- P3 -- 8 -- P4 -- 12

Avg waiting time: 0.75
Avg turnaround time: 3.50
```