College of Computer Engineering and Information Technology

Operating Systems 7505

FINAL PROJECT

CPU Scheduler Simulator

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Project Description

• The idea of the project is to receive a list of processes (fixed to 5 processes) with different arrival times and different CPU bursts. Also each process will have a size in bytes .

• You should write a program that will read these processes from a file called processes.txt that contains the list of process that should be scheduled. A sample input is like the file below.

• Your simulator should build the PCB for each process with required data structure. Your design for the PCB should be clear and clarified inside the source code of your simulator or as a separate documentation file using word or pdf format.

• Your simulator should be able to report the following results on the screen as soon as the last process is finished running using FCFS, SJF (non-preemptive), and RR with Q = y that will be given in the text file as well.

a. (15 %) A Gantt Chart that shows the execution times of the process, similar to what We had in the lecture examples.

b. (15 %) Finish time of each process, Waiting time for each process, Turnaround time for each process. Assume a CS = x time units that will be input from the text file as well.

c. (20 %) The averages of the required criteria's in part a. Average Waiting Time ....

d. (20 %) The CPU utilization.

Project Input File

The input file for the project will contain the following information:

• Physical memory size = msize... (Example 4096 bytes) Power of 2.

• Page size = Frame size = psize = fsize = ... (example = 512 bytes). Power of 2.

• Round Robin Quantum = Q = ... (example 10).

• Context Switch = CS = ... (example 1)

• Each process information as :

Process ID   Arrival Time   CPU Burst Size in Bytes

Sample file format **process.txt:**

4096

 512

 10

 1

0 3 10 8192

1 0 12 2048

2 1 3 512

3 5 21 4096

4 9 7 1024

What Is CPU Scheduling ?

CPU scheduling is a process that allows one process to use the CPU while the execution of another process is on hold(in waiting state) due to the unavailability of any resource like I/O etc, thereby making full use of the CPU. The aim of CPU scheduling is to make the system efficient, fast, and fair.

To simulate a CPU scheduler I defined a struct that represents the process building block, and three functions with an argument of type Process Building Block for First Come First Serve, Shortest Job First, and Round Robin.

The Three Used Algorithms

FCFS

I sorted the process according to its arrival time, then i set the initial values for first process Completion time for the first process equal arrival time for it plus burst time, the Turnaround time for the first process equals Completion time for it minus arrival time, the Waiting time for the first process is zero.

I filled the information of other processes by using for loop, in the loop, i used the condition to ensure that the arrival time of the process is smaller than or equal the completion time for the previous one, and if this condition comes true i fill the information of the process like this:

Completion time for process equals Completion time for previous process plus context switch plus burst time for Current process, the Turnaround time for Current process equals Completion time for it minus arrival time, the Waiting time for process equals completion time for the previous process minus arrival time plus context switch.

If the condition does not come true, that means the arrival time of the process is larger than the completion time for the previous one so, i fill the information of the process like this:

Completion time for the current process equals Burst time for the process plus arrival time of the process plus context switch, the Turnaround time for the current process equals completion time for it minus arrival time, the Waiting time for the current process equals turnaround time for the process minus burst time for the process plus context switch.

After filling all the process information i print these information in an understandable way and calculated the sum and the average of Waiting time, Turnaround time and Burst time, and i calculated the CPU utilization and it is equal to the sum of the burst time divided by the amount of the sum of the burst time add to the number of a context switch.

Finally, printing information for each process: process id, arrival time, burst time, completion time, turnaround time, Waiting time.

SJF

I sorted the process according to its arrival time, then i set the initial values for first process Completion time for the first process equal arrival time for it plus burst time, the Turnaround time for the first process equals Completion time for it minus arrival time, the Waiting time for the first process is zero.

I filled the information of other processes by using for loop, in the loop, and define a variable that represents the completion time of the previous process and uses it in another function called compared2, and this function used to compare the burst time between processes and if the process arrival time smaller than or equal to the completion time of the previous process. and in the loop, i used the condition to ensure that the arrival time of the process is smaller than or equal the completion time for the previous one, and if this condition comes true the Completion time for current process equals completion time for previous process plus context switch plus burst time for the current process. if the condition does not come true, that means the arrival time of the process is larger than the completion time for the previous one, then the Completion time for the current process equals burst time of the process plus the arrival time of the process. then if the condition comes true or not the Turnaround time for the current process equals completion time for it minus arrival time, the Waiting time for the current process equals completion time for the previous process minus arrival time for the current process plus context switch.

After filling all the process information i print these information in an understandable way and calculated the sum and the average of Waiting time, Turnaround time and Burst time, and we calculated the CPU Utilization and it is equal to the sum of the burst time divided by the amount of the sum of the burst time add to the number of a context switch.

Finally, printing information for each process: process id, arrival time, burst time, completion time, turnaround time, Waiting time.

RR

I sorted the process according to its arrival time and define an array to fill it with the remaining burst time of the process, then i make a copy of burst time to initialize remaining burst time. we define a waiting time array, a turnaround time array, a completion time array, a variable to represent the current time, a variable to count the number of a context switch, and initialize it to -1 (because in the first loop there is no context switch).

In a while loop, I defined a Boolean variable called done and set it to true. if the burst time of a process is greater than 0 that means it needs to process further, make done equal false, and if the remaining burst time greater than the quantum i increased the value of Current time by the quantum and increase count number of context switch by one, and decrease the remaining burst by quantum.

And if burst time is smaller than or equal to quantum, i need a Last cycle for this process, i increase the value of Current time by the remaining burst and increase count number of context switch by one, and i calculated Waiting time is current time minus time used by this process minus arrival switch, Turnaround times is current time minus arrival time plus the quantity of context switch, Completion time process gets fully executed make its remaining burst time =
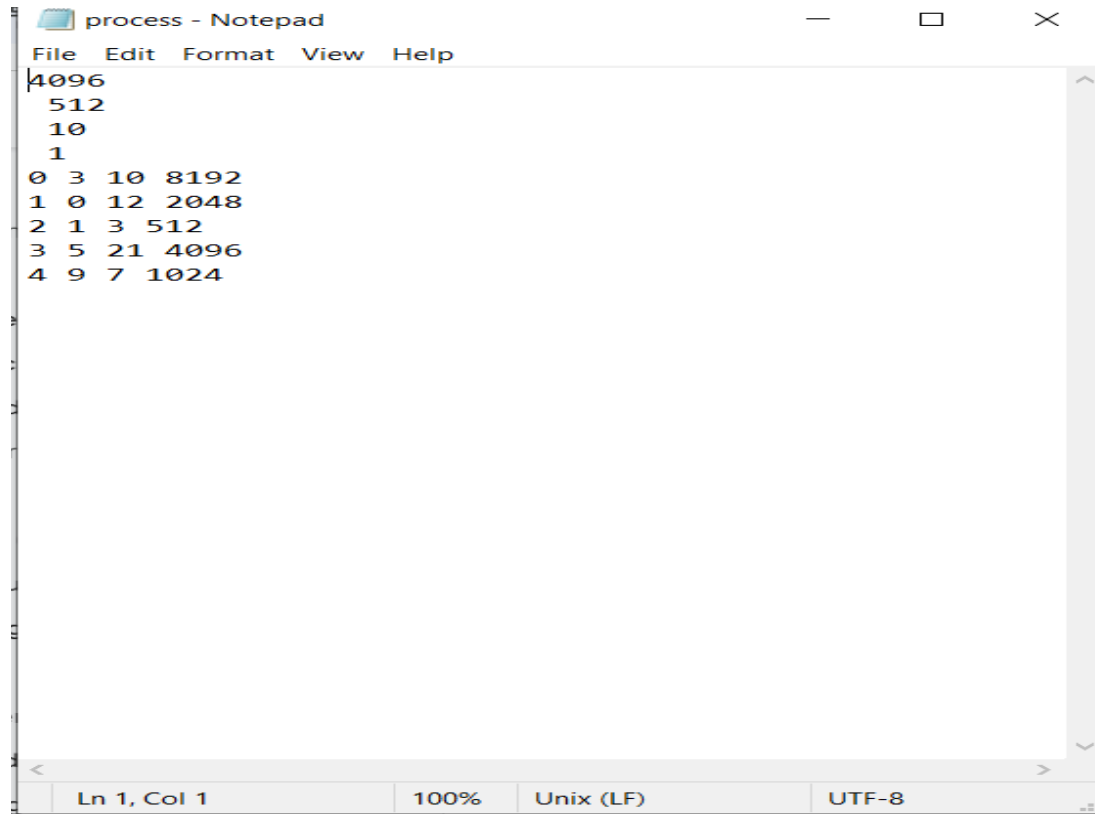
If done is equal to true, that means all processes have finished then i finish the loop. if not keep traversing processes in a round done.

After filling all the process information i print these information in an understandable way and calculated the sum and the average of Waiting time, Turnaround time and Burst time, and calculated the CPU Utilization and it is equal to the sum of the burst time divided by the amount of the sum of the burst time add to the nu context switch.

Finally, printing information for each process:process id, arrival time, burst time, completion time, turnaround time, Waiting time.

Execution Results

File #1:


```
process - Notepad                                    —    □    ×
File  Edit  Format  View  Help
4096
  512
  10
  1
0  3  10  8192
1  0  12  2048
2  1  3  512
3  5  21  4096
4  9  7  1024




                                                          ∧



                                                          ∨
<                                                    >
Ln 1, Col 1          100%      Unix (LF)        UTF-8
```
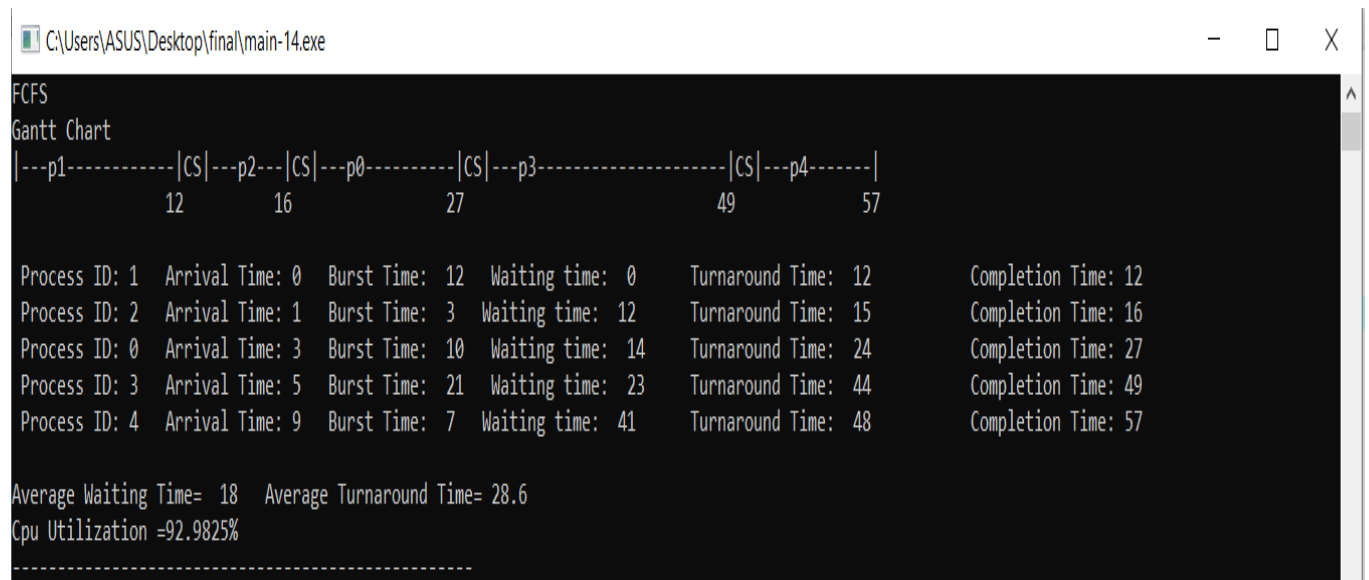
FCFS:


```
C:\Users\ASUS\Desktop\final\main-14.exe                          —   □   X
FCFS
Gantt Chart
|---p1------------|CS|---p2---|CS|---p0---------|CS|---p3--------------------|CS|---p4-------|
               12            16              27                        49            57


Process ID: 1   Arrival Time: 0   Burst Time:  12   Waiting time:  0    Turnaround Time:  12       Completion Time: 12
Process ID: 2   Arrival Time: 1   Burst Time:  3    Waiting time:  12   Turnaround Time:  15       Completion Time: 16
Process ID: 0   Arrival Time: 3   Burst Time:  10   Waiting time:  14   Turnaround Time:  24       Completion Time: 27
Process ID: 3   Arrival Time: 5   Burst Time:  21   Waiting time:  23   Turnaround Time:  44       Completion Time: 49
Process ID: 4   Arrival Time: 9   Burst Time:  7    Waiting time:  41   Turnaround Time:  48       Completion Time: 57


Average Waiting Time=  18   Average Turnaround Time= 28.6
Cpu Utilization =92.9825%
--------------------------------------------------------
```

SJF:

```
SJF
Gantt Chart
|---p1-----------|CS|---p2---|CS|---p4-------|CS|---p0----------|CS|---p3-------------------|
             12         16            24              35                    57


 Process ID: 1   Arrival Time: 0   Burst Time: 12   Waiting time: 0     Turnaround Time: 12       Completion Time: 12
 Process ID: 2   Arrival Time: 1   Burst Time: 3    Waiting time: 12    Turnaround Time: 15       Completion Time: 16
 Process ID: 4   Arrival Time: 9   Burst Time: 7    Waiting time: 8     Turnaround Time: 15       Completion Time: 24
 Process ID: 0   Arrival Time: 3   Burst Time: 10   Waiting time: 22    Turnaround Time: 32       Completion Time: 35
 Process ID: 3   Arrival Time: 5   Burst Time: 21   Waiting time: 31    Turnaround Time: 52       Completion Time: 57
Average Waiting Time=  14.6   Average Turnaround Time= 25.2
Cpu Utilization= 92.9825%
-----------------------------------------------
```
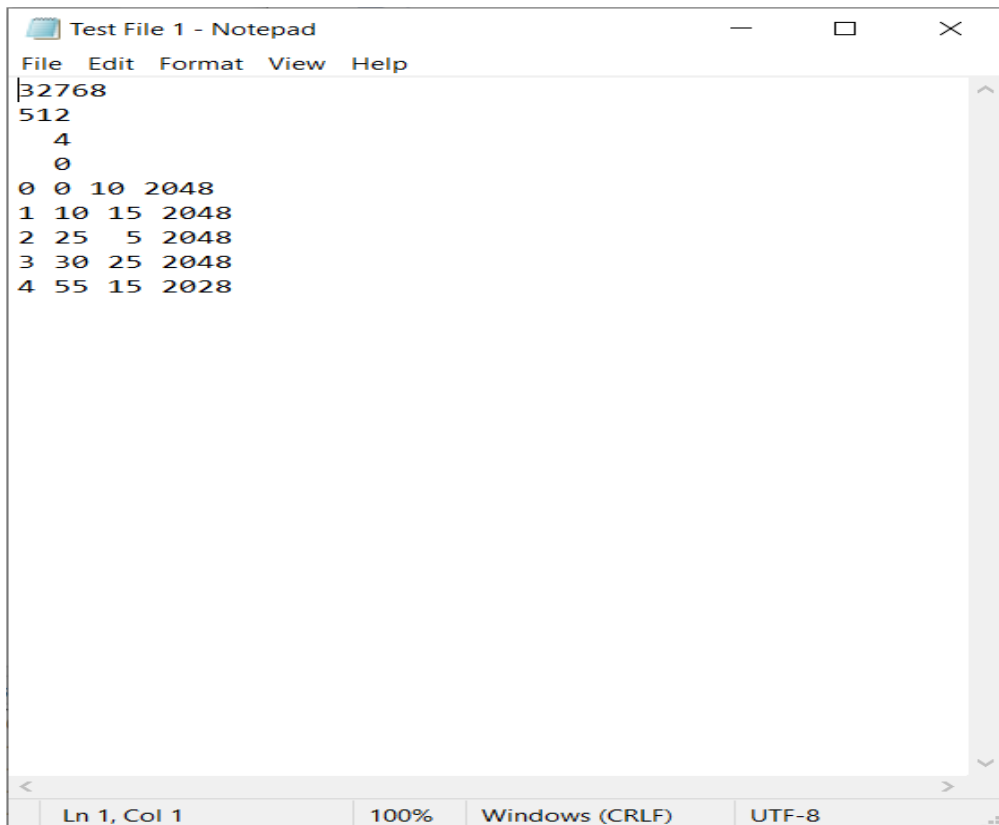
RR:

```
RR
Gantt Chart
|---p1----10|CS|---p2----14|CS|---p0----25|CS|---p3----36|CS|---p4----44|CS|---p1----47|CS|---p3----58|CS|---p3----60|CS


 Process ID: 1   Arrival Time: 0    Burst Time: 12   Waiting time: 35        Turnaround Time: 47        Completion Time: 47
 Process ID: 2   Arrival Time: 1    Burst Time: 3    Waiting time: 10     Turnaround Time: 13        Completion Time: 14
 Process ID: 0   Arrival Time: 3    Burst Time: 10   Waiting time: 12        Turnaround Time: 22        Completion Time: 25
 Process ID: 3   Arrival Time: 5    Burst Time: 21   Waiting time: 34        Turnaround Time: 55        Completion Time: 60
 Process ID: 4   Arrival Time: 9    Burst Time: 7    Waiting time: 28     Turnaround Time: 35        Completion Time: 44
Average Waiting Time=  23.8   Average Turnaround Time= 34.4


Cpu Utilization= 88.3333%
-----------------------------------------------
```
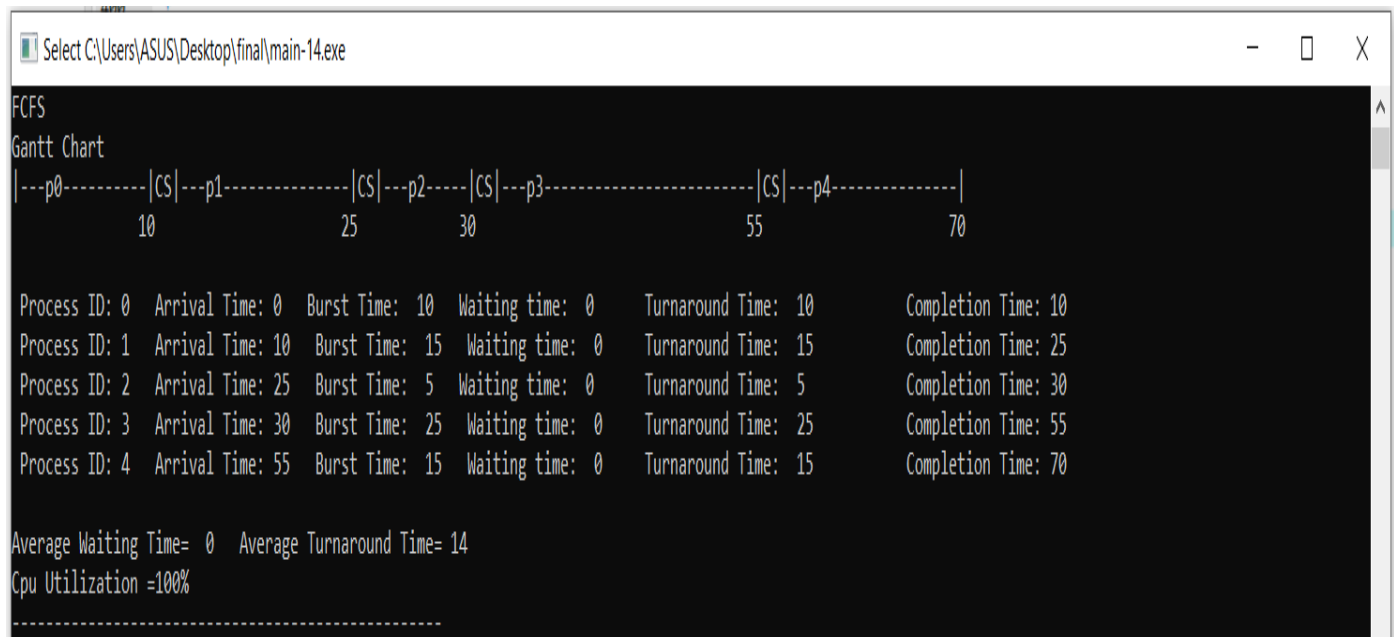
File #2:

```
Test File 1 - Notepad                    —    □    ✕
File  Edit  Format  View  Help
32768
512
   4
   0
0  0  10  2048
1  10  15  2048
2  25   5  2048
3  30  25  2048
4  55  15  2028




Ln 1, Col 1          100%    Windows (CRLF)    UTF-8
```

FCFS:

```
Select C:\Users\ASUS\Desktop\final\main-14.exe                          —   □   X

FCFS
Gantt Chart
|---p0----------|CS|---p1--------------|CS|---p2-----|CS|---p3-----------------------|CS|---p4--------------|
              10                      25            30                              55                    70


Process ID: 0   Arrival Time: 0    Burst Time:  10   Waiting time:  0    Turnaround Time:  10      Completion Time: 10
Process ID: 1   Arrival Time: 10   Burst Time:  15   Waiting time:  0    Turnaround Time:  15      Completion Time: 25
Process ID: 2   Arrival Time: 25   Burst Time:  5    Waiting time:  0    Turnaround Time:  5       Completion Time: 30
Process ID: 3   Arrival Time: 30   Burst Time:  25   Waiting time:  0    Turnaround Time:  25      Completion Time: 55
Process ID: 4   Arrival Time: 55   Burst Time:  15   Waiting time:  0    Turnaround Time:  15      Completion Time: 70


Average Waiting Time=  0   Average Turnaround Time= 14
Cpu Utilization =100%
--------------------------------------------------------
```

SJF:

```
SJF
Gantt Chart
|---p0----------|CS|---p1--------------|CS|---p2-----|CS|---p3-----------------------|CS|---p4--------------|
            10                  25           30                          55               70


 Process ID: 0   Arrival Time: 0   Burst Time: 10   Waiting time: 0    Turnaround Time: 10       Completion Time: 10
 Process ID: 1   Arrival Time: 10  Burst Time: 15   Waiting time: 0    Turnaround Time: 15       Completion Time: 25
 Process ID: 2   Arrival Time: 25  Burst Time: 5    Waiting time: 0    Turnaround Time: 5        Completion Time: 30
 Process ID: 3   Arrival Time: 30  Burst Time: 25   Waiting time: 0    Turnaround Time: 25       Completion Time: 55
 Process ID: 4   Arrival Time: 55  Burst Time: 15   Waiting time: 0    Turnaround Time: 15       Completion Time: 70
Average Waiting Time=  0   Average Turnaround Time= 14
Cpu Utilization= 100%
-------------------------------------------------
```

RR:
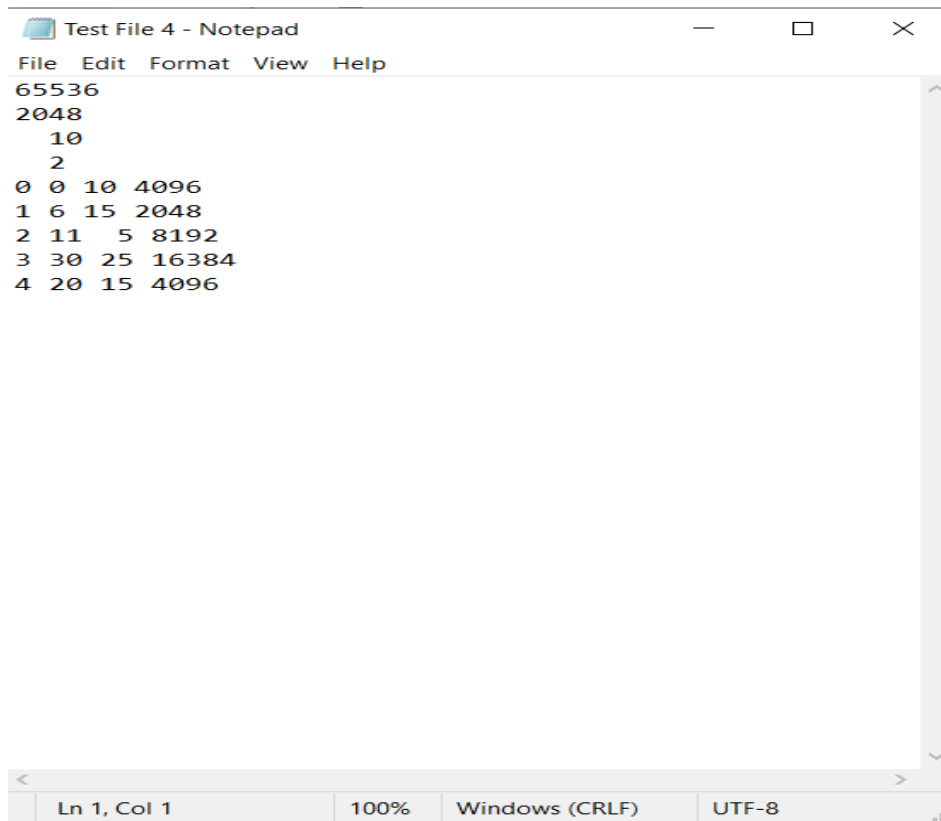
```
RR
Gantt Chart
|---p0----4|CS|---p0----8|CS|---p0----10|CS|---p1----14|CS|---p1----18|CS|---p1----22|CS|---p1----25|CS|---p2----29|CS|---p2----30|CS|---p3----34|CS|---p3----38|
CS|---p3----42|CS|---p3----46|CS|---p3----50|CS|---p3----54|CS|---p3----55|CS|---p4----59|CS|---p4----63|CS|---p4----67|CS|---p4----70|CS


 Process ID: 0   Arrival Time: 0    Burst Time: 10   Waiting time: 0    Turnaround Time: 10       Completion Time: 10
 Process ID: 1   Arrival Time: 10   Burst Time: 15   Waiting time: 0       Turnaround Time: 15         Completion Time: 25
 Process ID: 2   Arrival Time: 25   Burst Time: 5    Waiting time: 0    Turnaround Time: 5        Completion Time: 30
 Process ID: 3   Arrival Time: 30   Burst Time: 25   Waiting time: 0       Turnaround Time: 25         Completion Time: 55
 Process ID: 4   Arrival Time: 55   Burst Time: 15   Waiting time: 0       Turnaround Time: 15         Completion Time: 70
Average Waiting Time=  0   Average Turnaround Time= 14


Cpu Utilization= 100%
-------------------------------------------------
```

FILe #3:

FCFS:

SJF:
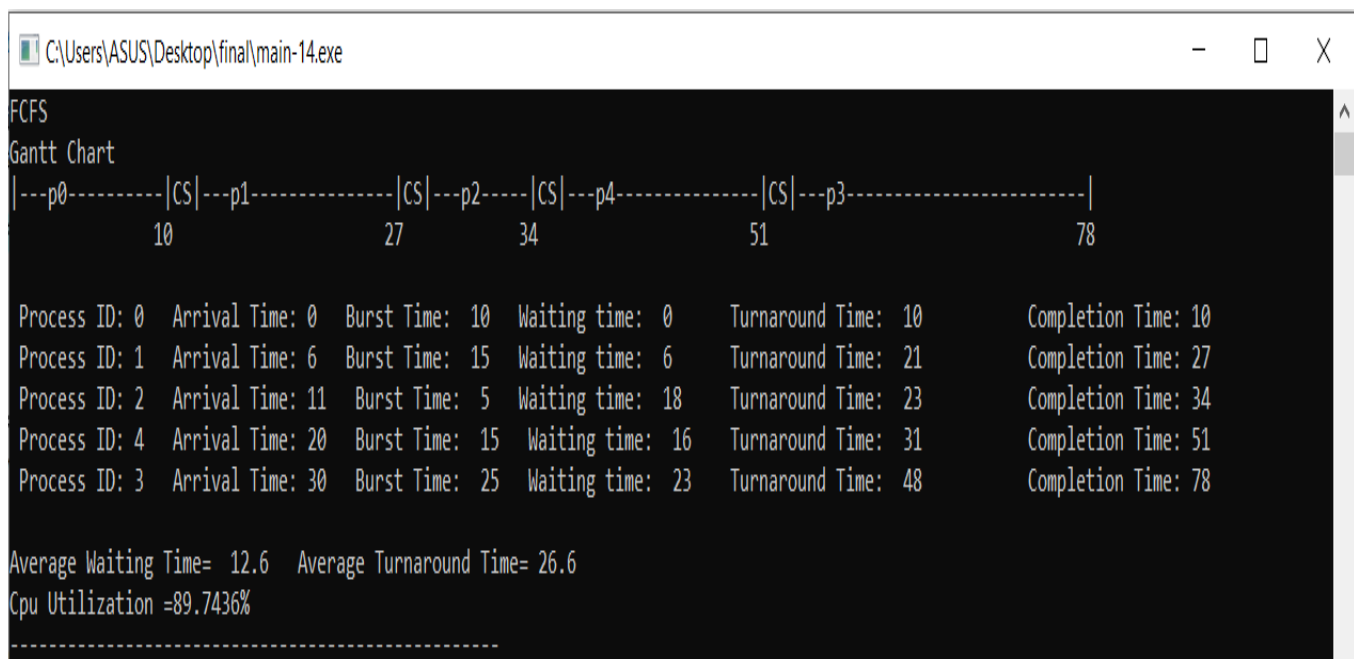
```
--------------------------------------------------
SJF
Gantt Chart
|---p0----------|CS|---p1--------------|CS|---p2-----|CS|---p4--------------|CS|---p3-----------------------|
           10                  27          34               51                          78

 Process ID: 0   Arrival Time: 0   Burst Time:  10   Waiting time:  0    Turnaround Time:  10        Completion Time: 10
 Process ID: 1   Arrival Time: 6   Burst Time:  15   Waiting time:  6    Turnaround Time:  21        Completion Time: 27
 Process ID: 2   Arrival Time: 11  Burst Time:  5    Waiting time:  18   Turnaround Time:  23        Completion Time: 34
 Process ID: 4   Arrival Time: 20  Burst Time:  15   Waiting time:  16   Turnaround Time:  31        Completion Time: 51
 Process ID: 3   Arrival Time: 30  Burst Time:  25   Waiting time:  23   Turnaround Time:  48        Completion Time: 78
Average Waiting Time=  12.6   Average Turnaround Time= 26.6
Cpu Utilization= 89.7436%
--------------------------------------------------
```
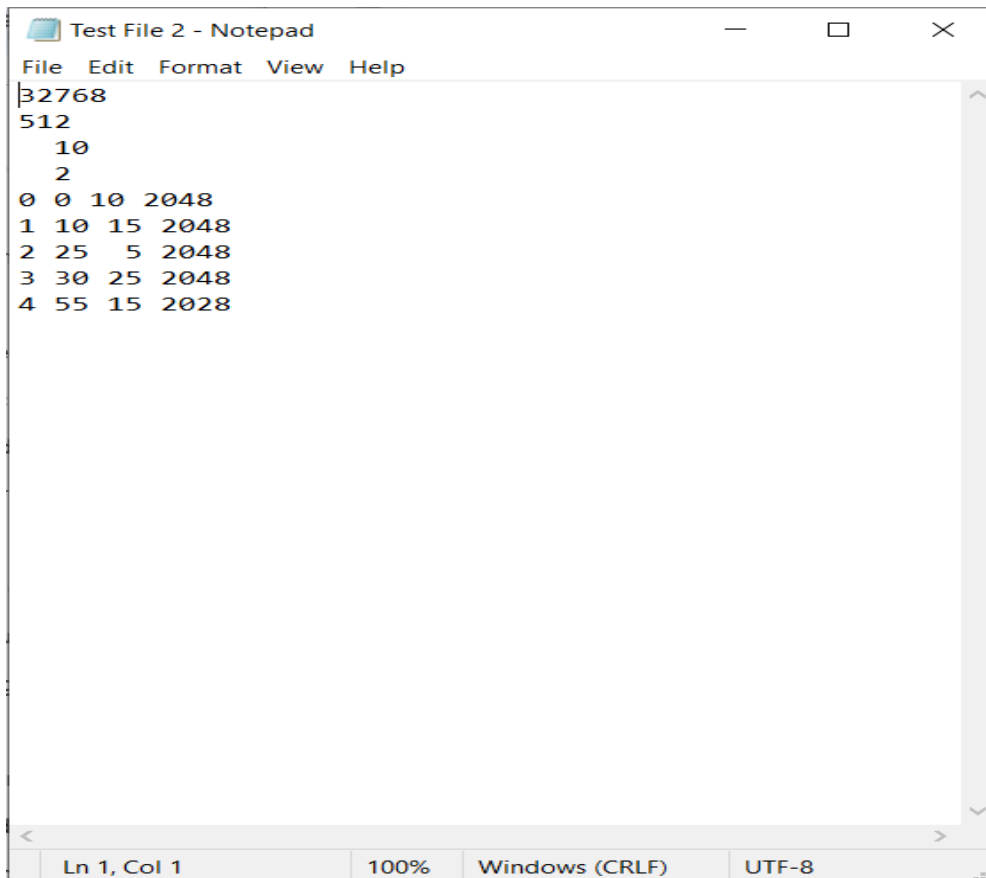
RR:

```
RR
Gantt Chart
|---p0----10|CS|---p1----22|CS|---p2----29|CS|---p4----41|CS|---p3----53|CS|---p1----60|CS|---p4----67|CS|---p3----79|CS|---p3----86|CS

 Process ID: 0  Arrival Time: 0    Burst Time: 10  Waiting time: 0    Turnaround Time: 10       Completion Time: 10
 Process ID: 1  Arrival Time: 6    Burst Time: 15  Waiting time: 39       Turnaround Time: 54        Completion Time: 60
 Process ID: 2  Arrival Time: 11   Burst Time: 5   Waiting time: 13       Turnaround Time: 18        Completion Time: 29
 Process ID: 4  Arrival Time: 20   Burst Time: 15  Waiting time: 32       Turnaround Time: 47        Completion Time: 67
 Process ID: 3  Arrival Time: 30   Burst Time: 25  Waiting time: 31       Turnaround Time: 56        Completion Time: 86
Average Waiting Time= 23   Average Turnaround Time= 37


Cpu Utilization= 81.3953%
--------------------------------------------------
```
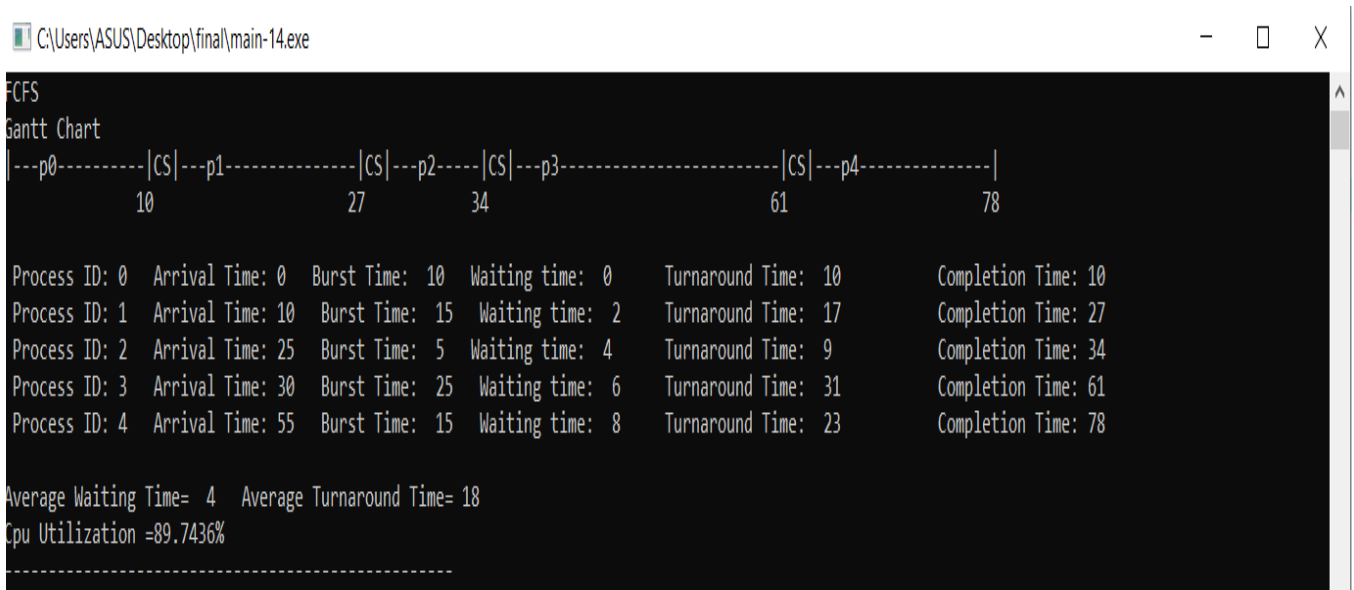
File #4:

```
Test File 2 - Notepad                      —    □    ×
File  Edit  Format  View  Help
32768
512
   10
    2
0  0  10  2048
1  10  15  2048
2  25   5  2048
3  30  25  2048
4  55  15  2028




Ln 1, Col 1              100%   Windows (CRLF)      UTF-8
```

FCFS:

```
C:\Users\ASUS\Desktop\final\main-14.exe                              —   □   X

FCFS
Gantt Chart
|---p0----------|CS|---p1--------------|CS|---p2-----|CS|---p3------------------------|CS|---p4--------------|
               10                      27            34                               61                    78


Process ID: 0   Arrival Time: 0    Burst Time:  10   Waiting time:  0    Turnaround Time:  10      Completion Time: 10
Process ID: 1   Arrival Time: 10   Burst Time:  15   Waiting time:  2    Turnaround Time:  17      Completion Time: 27
Process ID: 2   Arrival Time: 25   Burst Time:  5    Waiting time:  4    Turnaround Time:  9       Completion Time: 34
Process ID: 3   Arrival Time: 30   Burst Time:  25   Waiting time:  6    Turnaround Time:  31      Completion Time: 61
Process ID: 4   Arrival Time: 55   Burst Time:  15   Waiting time:  8    Turnaround Time:  23      Completion Time: 78


Average Waiting Time=  4   Average Turnaround Time= 18
Cpu Utilization =89.7436%

-------------------------------------------------
```

SJF:

```
SJF
Gantt Chart
|---p0----------|CS|---p1--------------|CS|---p2-----|CS|---p3----------------------|CS|---p4-------------|
           10                    27         34                          61                    78


 Process ID: 0   Arrival Time: 0   Burst Time:  10   Waiting time:  0    Turnaround Time:  10       Completion Time: 10
 Process ID: 1   Arrival Time: 10  Burst Time:  15   Waiting time:  2    Turnaround Time:  17       Completion Time: 27
 Process ID: 2   Arrival Time: 25  Burst Time:  5    Waiting time:  4    Turnaround Time:  9        Completion Time: 34
 Process ID: 3   Arrival Time: 30  Burst Time:  25   Waiting time:  6    Turnaround Time:  31       Completion Time: 61
 Process ID: 4   Arrival Time: 55  Burst Time:  15   Waiting time:  8    Turnaround Time:  23       Completion Time: 78
Average Waiting Time=  4   Average Turnaround Time= 18
Cpu Utilization= 89.7436%

------------------------------------------------
```
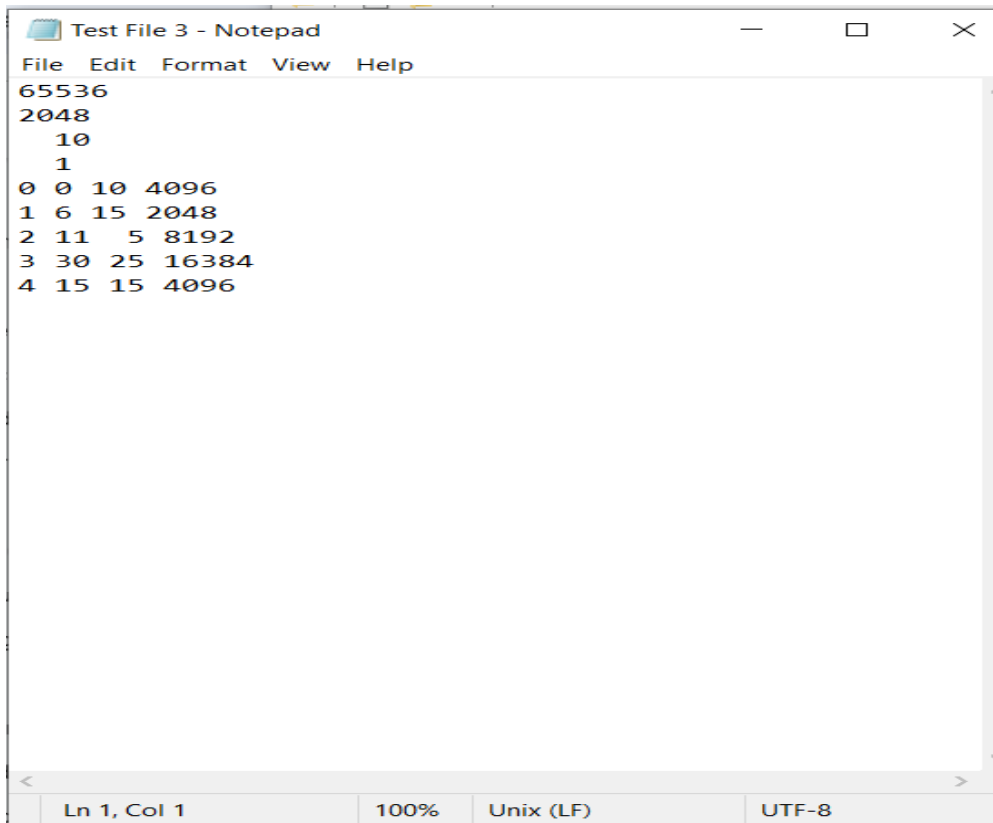
RR:

```
RR
Gantt Chart
|---p0----10|CS|---p1----22|CS|---p1----29|CS|---p2----36|CS|---p3----48|CS|---p3----60|CS|---p4----72|CS|---p3----79|CS|---p4----86|CS


 Process ID: 0   Arrival Time: 0    Burst Time:  10   Waiting time:  0     Turnaround Time:  10        Completion Time: 10
 Process ID: 1   Arrival Time: 10   Burst Time:  15   Waiting time:  4        Turnaround Time:  19          Completion Time: 29
 Process ID: 2   Arrival Time: 25   Burst Time:  5    Waiting time:  6     Turnaround Time:  11         Completion Time: 36
 Process ID: 3   Arrival Time: 30   Burst Time:  25   Waiting time:  24       Turnaround Time:  49          Completion Time: 79
 Process ID: 4   Arrival Time: 55   Burst Time:  15   Waiting time:  16       Turnaround Time:  31          Completion Time: 86
Average Waiting Time= 10   Average Turnaround Time= 24


Cpu Utilization= 81.3953%

------------------------------------------------
```
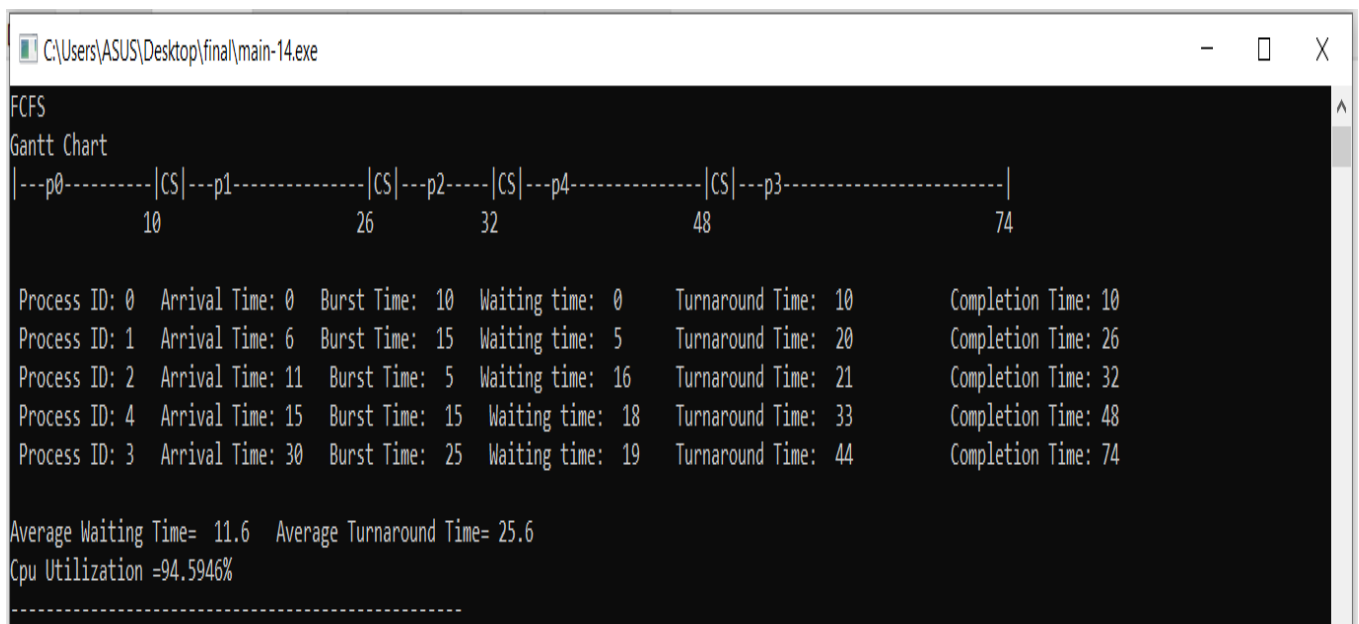
File #5:

FCFS:

SJF:

```
SJF
Gantt Chart
|---p0---------|CS|---p1-------------|CS|---p2-----|CS|---p4--------------|CS|---p3----------------------|
            10                    26          32                  48                          74


 Process ID: 0   Arrival Time: 0   Burst Time: 10   Waiting time: 0      Turnaround Time: 10        Completion Time: 10
 Process ID: 1   Arrival Time: 6   Burst Time: 15   Waiting time: 5      Turnaround Time: 20        Completion Time: 26
 Process ID: 2   Arrival Time: 11  Burst Time: 5    Waiting time: 16     Turnaround Time: 21        Completion Time: 32
 Process ID: 4   Arrival Time: 15  Burst Time: 15   Waiting time: 18     Turnaround Time: 33        Completion Time: 48
 Process ID: 3   Arrival Time: 30  Burst Time: 25   Waiting time: 19     Turnaround Time: 44        Completion Time: 74
Average Waiting Time= 11.6   Average Turnaround Time= 25.6
Cpu Utilization= 94.5946%
-----------------------------------------------
```

RR:

```
RR
Gantt Chart
|---p0----10|CS|---p1----21|CS|---p2----27|CS|---p4----38|CS|---p3----49|CS|---p1----55|CS|---p4----61|CS|---p3----72|CS|---p3----78|CS


 Process ID: 0   Arrival Time: 0    Burst Time: 10   Waiting time: 0    Turnaround Time: 10       Completion Time: 10
 Process ID: 1   Arrival Time: 6    Burst Time: 15   Waiting time: 34        Turnaround Time: 49        Completion Time: 55
 Process ID: 2   Arrival Time: 11   Burst Time: 5    Waiting time: 11        Turnaround Time: 16        Completion Time: 27
 Process ID: 4   Arrival Time: 15   Burst Time: 15   Waiting time: 31        Turnaround Time: 46        Completion Time: 61
 Process ID: 3   Arrival Time: 30   Burst Time: 25   Waiting time: 23        Turnaround Time: 48        Completion Time: 78
Average Waiting Time= 19.8   Average Turnaround Time= 33.8


Cpu Utilization= 89.7436%
-----------------------------------------------
```