Name :- Khan Faisal SAP ID :- 60004240019
Class :- CA
Roll no :- 197
Batch :- C1/2

EXPERIMENT - (3)

* **Aim :-** Process scheduling algorithms like FCFS, SJF, RoundRobin & Priority.

* **Theory :-**

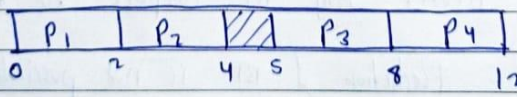
1] FCFS Algorithm :-

- Stands First come First serve.
- Simplest scheduling algo., id assign CPU to the process which arrive first.
- Non-preemptive algo.

- Example :-

PNo	AT	BT	CT	TAT	WT	RT
P1	0	2	2	2	0	0
P2	1	2	4	3	1	1
P3	5	3	8	3	0	0
P4	6	4	12	6	2	2
Avg				3.5	.75	.75

Gantt chart



- Adv :- Simple, easy to understand
- Disadv :- suffer from convoy effect.

3] Round Robin Algo :-

- It is a pre-emptive Algo.
- We fix a TQ up to which a process can hold the CPU in one go, with in which either a process terminates or process must release the CPU & re-enters in the circular Q & wait for the next chance.
- Here RQ will be treated as CQ.

- Example :- TQ = 2

PNo	AT	BT	CT	TAT	WT
P_0	0	5	13	13	8
P_1	1	3	12	11	8
P_2	2	1	5	3	2
P_3	3	2	9	6	4
P_4	4	3	14	10	7
Avg				8.6	5.8

P_0 P_1 P_2 P_0 P_3 P_4 P_1 P_0 P_4

Gantt	P_0	P_1	P_2	P_0	P_3	P_4	P_1	P_0	P_4
chart	0	1	4	5	7	9	11	12	13	14

- Adv :- Perform best in terms of RT
- Disdv :- Longer process may starv.

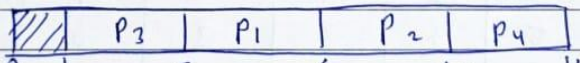
2] SJF Algo. :-

- Stands for Shortest Job First.
- Out of all available process, CPU is assigned to the process having smallest BT requirement.
- If there is a tie, FCFS is used to break tie.
- It can be used both with non-preemptive & pre-emptive approach.

- Example :-

PNO	AT	BT	CT	TAT	WT	RT
P_1	1	3	6	5	2	2
P_2	2	4	10	8	4	4
P_3	1	2	3	2	0	0
P_4	4	4	14	10	6	6
Avg				6.25	3	3

Gantt chart



- Adv :- Better Avg. RT compare to FCFS.

- DIS-adv :- Prediction of BT is not possible.

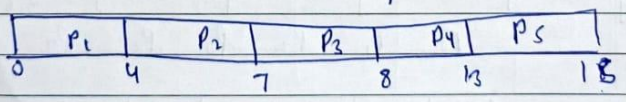
4] Priority Algo :-

- Here a priority is associated with each process.
- At any instance of time at of all available process, CPU is allocated to the process which process the highest priority.
- Tie broken using FCFS order.
- Supports Both pre-emptive & non-preemptive

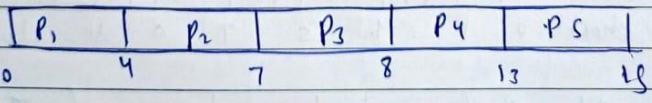
- Example

PNo	AT	BT	Priority	CT	TAT	WT
P_1	0	4	2	4	4	0
P_2	1	3	3	7	6	3
P_3	2	1	4	8	6	5
P_4	3	5	5	13	10	5
P_5	4	2	5	15	11	9
Avg					7.4	4.4

Non-pre-emptive



Pre-emptive



- Adv :- Provides a facility of priority specially for system process
- Disadv :- starvation

* Conclusion :-

Process scheduling Algo are vital in optimizing the performance of OS by managing execution of processes effectively. Each algorithm has its own strengths & weaknesses. Choosing the right algo. depends on system requirements like fairness, efficiency, responsiveness etc.

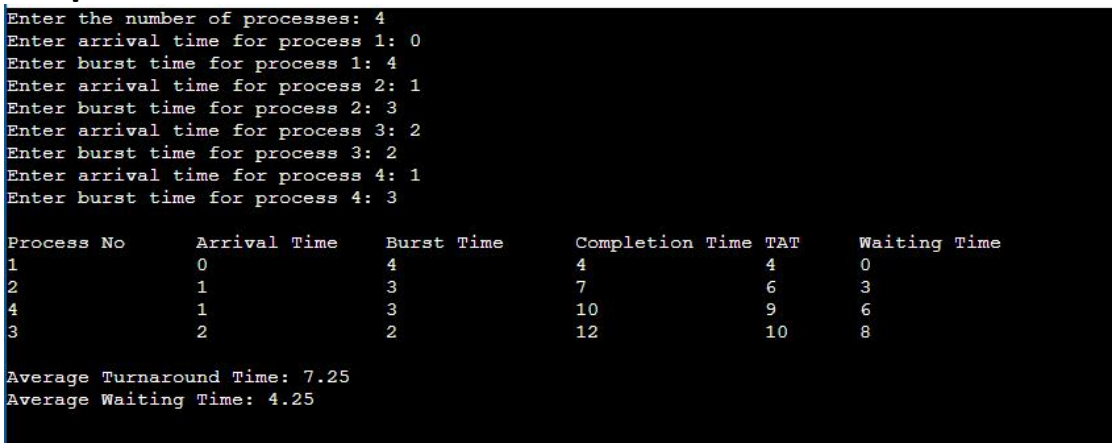
Program (FCFS):

```
#include <stdio.h>

struct fcfs {
   int pNo;
   int AT;
   int BT;
   int CT;
   int TAT;
   int WT;
};

void sort(struct fcfs arr[], int n) {
   struct fcfs temp;
   for (int i = 0; i < n - 1; i++) {
      for (int j = i + 1; j < n; j++) {
         if (arr[i].AT > arr[j].AT) {
            temp = arr[i];
            arr[i] = arr[j];
            arr[j] = temp;
         }
      }
   }
}

int main() {
   int n, atat = 0, awt = 0, temp = 0;

   printf("Enter the number of processes: ");
   scanf("%d", &n);
   struct fcfs arr[n];

   // Input process details
   for (int i = 0; i < n; i++) {
      arr[i].pNo = i + 1;
```

```
        printf("Enter arrival time for process %d: ", i + 1);
        scanf("%d", &arr[i].AT);
        printf("Enter burst time for process %d: ", i + 1);
        scanf("%d", &arr[i].BT);
    }

    sort(arr, n); // Sort by arrival time

    // Calculate Completion Time, Turnaround Time, and Waiting
Time
    for (int i = 0; i < n; i++) {
        if (temp < arr[i].AT) { // CPU is idle
            printf("\nIdle time: %d -> %d\n", temp, arr[i].AT);
            temp = arr[i].AT; // Update current time
        }

        arr[i].CT = temp + arr[i].BT; // Compute Completion Time
        arr[i].TAT = arr[i].CT - arr[i].AT; // Turnaround Time
        arr[i].WT = arr[i].TAT - arr[i].BT; // Waiting Time

        atat += arr[i].TAT; // Accumulate Turnaround Time
        awt += arr[i].WT;   // Accumulate Waiting Time

        temp = arr[i].CT; // Update temp to latest Completion Time
    }

    // Display process details
    printf("\nProcess No\tArrival Time\tBurst Time\tCompletion
Time\tTAT\tWaiting Time\n");
    for (int i = 0; i < n; i++) {
        printf("%d\t\t%d\t\t%d\t\t%d\t\t%d\t%d\n",
               arr[i].pNo, arr[i].AT, arr[i].BT, arr[i].CT, arr[i].TAT,
arr[i].WT);
    }
```

```
    // Display average times
    printf("\nAverage Turnaround Time: %.2f\n", (float)atat / n);
    printf("Average Waiting Time: %.2f\n", (float)awt / n);

    return 0;
}
```

Output:



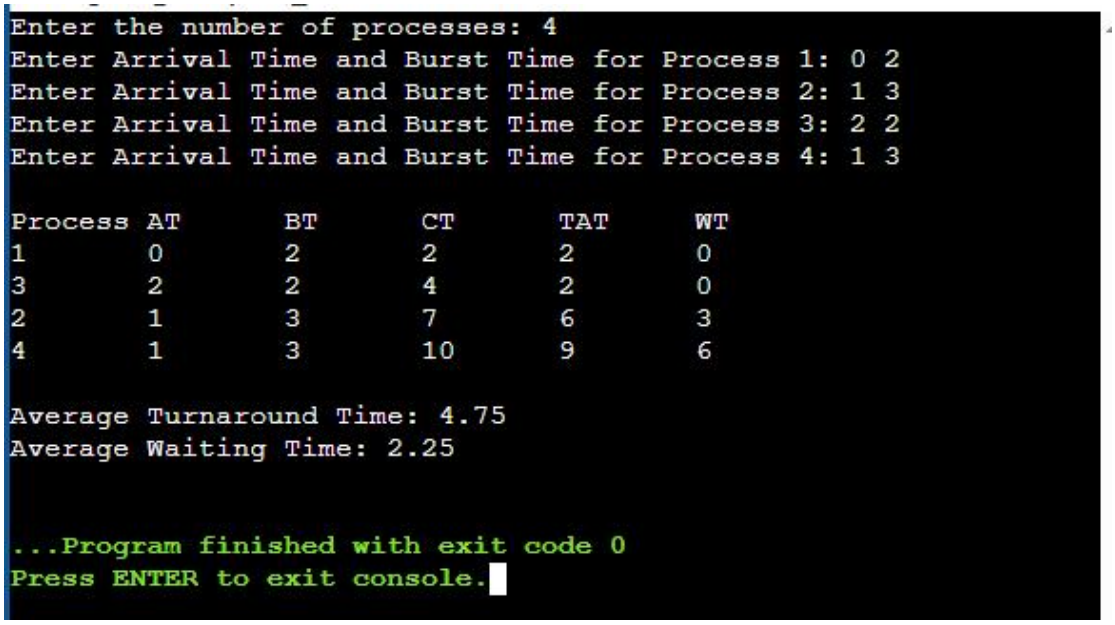
Program (SJF):

```
#include <stdio.h>

struct Process {
   int pNo, AT, BT, CT, TAT, WT;
};

void sortProcesses(struct Process p[], int n) {
   struct Process temp;
   for (int i = 0; i < n - 1; i++) {
      for (int j = i + 1; j < n; j++) {
         // Sort based on Burst Time (if same, sort by
Arrival Time)
         if ((p[i].BT > p[j].BT) || (p[i].BT == p[j].BT &&
p[i].AT > p[j].AT)) {
            temp = p[i];
            p[i] = p[j];
            p[j] = temp;
         }
      }
   }
}

void sjfNonPreemptive(struct Process p[], int n) {
   int temp = 0, totalTAT = 0, totalWT = 0;

   sortProcesses(p, n);  // Sort by burst time

   for (int i = 0; i < n; i++) {
      if (temp < p[i].AT) {
         printf("Idle Time: %d -> %d", temp , p[i].AT);
```

```
            temp = p[i].AT;  // CPU remains idle
        }
        p[i].CT = temp + p[i].BT;  // Completion Time
        p[i].TAT = p[i].CT - p[i].AT;  // Turnaround Time
        p[i].WT = p[i].TAT - p[i].BT;  // Waiting Time

        totalTAT += p[i].TAT;
        totalWT += p[i].WT;
        temp = p[i].CT;
    }

    printf("\nProcess\tAT\tBT\tCT\tTAT\tWT\n");
    for (int i = 0; i < n; i++) {
        printf("%d\t%d\t%d\t%d\t%d\t%d\n", p[i].pNo,
p[i].AT, p[i].BT, p[i].CT, p[i].TAT, p[i].WT);
    }

    printf("\nAverage Turnaround Time: %.2f",
(float)totalTAT / n);
    printf("\nAverage Waiting Time: %.2f\n",
(float)totalWT / n);
}

int main() {
    int n;
    printf("Enter the number of processes: ");
    scanf("%d", &n);

    struct Process p[n];

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

```
        p[i].pNo = i + 1;
        printf("Enter Arrival Time and Burst Time for
Process %d: ", i + 1);
        scanf("%d %d", &p[i].AT, &p[i].BT);
    }

    sjfNonPreemptive(p, n);

    return 0;
}
```

Output:



Program (Round Robin):

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

#define Q_SIZE 1000

int Q[Q_SIZE], front = -1, rear = -1;

struct RR {
   int pNo;
   int AT;
   int BT;
   int original_BT;
   int CT;
   int TAT;
   int WT;
};

// Function to sort processes based on arrival time
void sort(struct RR arr[], int n) {
   struct RR temp;
   for (int i = 0; i < n; i++) {
      for (int j = i + 1; j < n; j++) {
         if (arr[i].AT > arr[j].AT) {
            temp = arr[i];
            arr[i] = arr[j];
            arr[j] = temp;
         }
      }
   }
}
```

```
// Function to add a process to the queue
void Enqueue(int value) {
   if (rear == Q_SIZE - 1) {
      printf("\nQueue is full.");
      return;
   }
   if (front == -1) {
      front = 0;
   }
   rear++;
   Q[rear] = value;
}

// Function to remove a process from the queue
int Dequeue() {
   if (front == -1 || front > rear) {
      return -1; // Queue is empty
   }
   int x = Q[front];
   front++;
   return x;
}

// Function to check if the queue is empty
bool isEmpty() {
   return front == -1 || front > rear;
}

// Function to check if a process is already in the queue
bool contains(int value) {
```

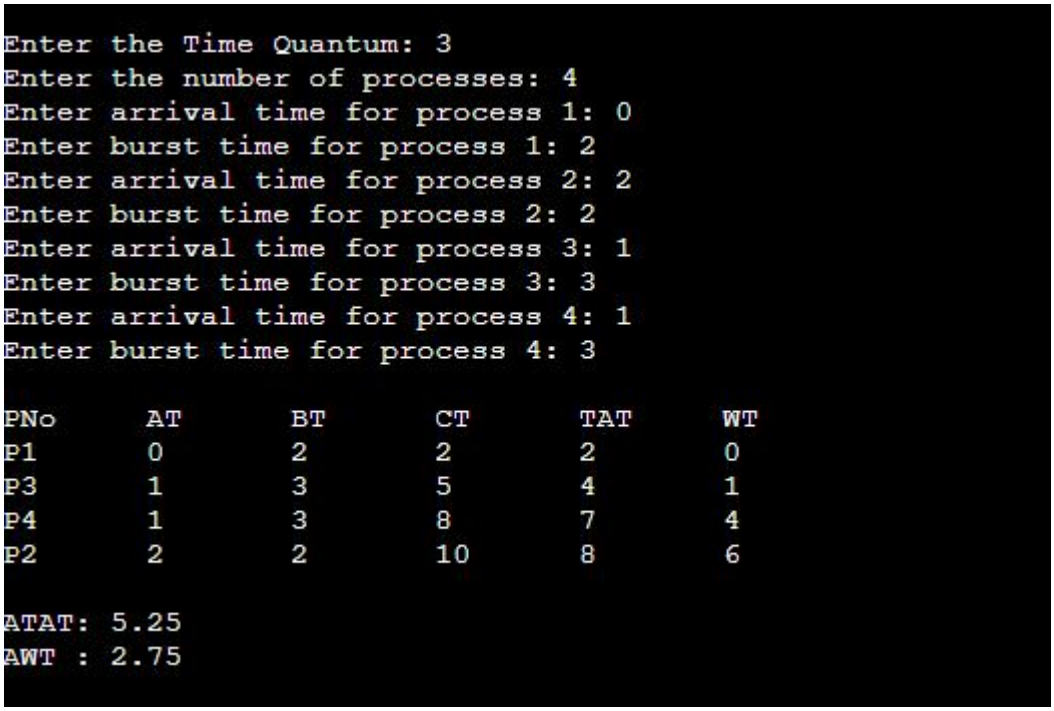
```
    for (int i = front; i <= rear; i++) {
        if (Q[i] == value) {
            return true;
        }
    }
    return false;
}

int main() {
    int n, TQ, atat = 0, awt = 0, temp = 0;

    // Take Time Quantum
    printf("\nEnter the Time Quantum: ");
    scanf("%d", &TQ);

    printf("Enter the number of processes: ");
    scanf("%d", &n);
    struct RR arr[n];

    // Input process details
    for (int i = 0; i < n; i++) {
        arr[i].pNo = i + 1;
        printf("Enter arrival time for process %d: ", i + 1);
        scanf("%d", &arr[i].AT);
        printf("Enter burst time for process %d: ", i + 1);
        scanf("%d", &arr[i].BT);
        arr[i].original_BT = arr[i].BT; // Store original burst
time
    }

    // Sort processes as per the arrival time
```

```
    sort(arr, n);

    // Initially add the first process to the queue
    Enqueue(0); // 0 index contains the first process

    // Process the queue
    while (!isEmpty()) {
        int i = Dequeue();

        // Handle idle time if no process is ready
        if (temp < arr[i].AT) {
            printf("\nIdle time: %d -> %d\n", temp, arr[i].AT);
            temp = arr[i].AT;
        }

        // Execute the process for the time quantum or its
remaining burst time
        if (arr[i].BT <= TQ) {
            temp += arr[i].BT;
            arr[i].BT = 0; // Process finishes
            arr[i].CT = temp;
        } else {
            temp += TQ;
            arr[i].BT -= TQ;
        }

        // Add newly arrived processes to the queue
        for (int j = 0; j < n; j++) {
            if (arr[j].AT <= temp && arr[j].BT > 0
&& !contains(j)) {
                Enqueue(j);
```

```
            }
        }

        // If the current process is not finished, add it back
to the queue
        if (arr[i].BT > 0) {
            Enqueue(i);
        }
    }

    // Calculate TAT, WT, ATAT, and AWT
    for (int i = 0; i < n; i++) {
        arr[i].TAT = arr[i].CT - arr[i].AT;
        arr[i].WT = arr[i].TAT - arr[i].original_BT;

        atat += arr[i].TAT;
        awt += arr[i].WT;
    }

    // Print results
    printf("\nPNo\tAT\tBT\tCT\tTAT\tWT\n");
    for (int i = 0; i < n; i++) {
        printf("P%d\t%d\t%d\t%d\t%d\t%d\n",
               arr[i].pNo,
               arr[i].AT,
               arr[i].original_BT,
               arr[i].CT,
               arr[i].TAT,
               arr[i].WT);
    }
```

```
    // Print averages
    printf("\nATAT: %.2f", (float)atat / n);
    printf("\nAWT : %.2f\n", (float)awt / n);


    return 0;
}
```

Output:



Program (Priority Non Pre-emptive):

```
#include <stdio.h>

// Lesser no higher priority
struct priority{
   int pNo;
   int AT;
   int BT;
   int priority;
   int CT;
   int TAT;
   int WT;
};

void sort(struct priority arr[], int n){
   struct priority temp;
   for(int i =0 ; i < n ; i++){
      for(int j = i + 1; j < n ; j++){
         // Sort as per the priority and AT
         if(arr[i].priority > arr[j].priority || (arr[i].priority
== arr[j].priority && arr[i].AT >arr[j].AT)){
            temp = arr[i];
            arr[i] = arr[j];
            arr[j] = temp;
         }
      }
   }
}

int main(){
   int n, atat = 0, awt = 0 , temp = 0;
```

```
   printf("Enter the no of process:");
   scanf("%d", &n);
   struct priority arr[n];

   for(int i = 0 ; i < n ; i++){
      arr[i].pNo = i+1;
      printf("Enter the AT, BT & Priority for the
process %d: ", i+1);
      scanf("%d %d %d", &arr[i].AT, &arr[i].BT,
&arr[i].priority);
   }

   sort(arr, n);

   // Calculate CT, TAT, WT, ATAT & AWt
   for(int i = 0 ; i < n ; i++){
      // Handle idle time
      if(temp < arr[i].AT){
         printf("Idle time: %d -> %d\n", temp, arr[i].AT);
         temp = arr[i].AT;
      }

      arr[i].CT = temp + arr[i].BT;
      arr[i].TAT = arr[i].CT - arr[i].AT;
      arr[i].WT = arr[i].TAT - arr[i].BT;
      temp = arr[i].CT;

      atat += arr[i].TAT;
      awt += arr[i].WT;
   }
```

```
    // Display results in short form
    printf("\nPNo\tAT\tBT\tPri\tCT\tTAT\tWT\n");
    for (int i = 0; i < n; i++) {
        printf("P%d\t%d\t%d\t%d\t%d\t%d\t%d\n",
               arr[i].pNo,
               arr[i].AT,
               arr[i].BT,
               arr[i].priority,
               arr[i].CT,
               arr[i].TAT,
               arr[i].WT);
    }

    // Display average times
    printf("\nATAT: %.2f", (float)atat / n);
    printf("\nAWT : %.2f\n", (float)awt / n);

    return 0;
}
```

Output:

```
Enter the no of process:3
Enter the AT, BT & Priority for the process 1: 0 4 2
Enter the AT, BT & Priority for the process 2: 1 3 1
Enter the AT, BT & Priority for the process 3: 2 2 3
Idle time: 0 -> 1

PNo     AT      BT      Pri     CT      TAT     WT
P2      1       3       1       4       3       0
P1      0       4       2       8       8       4
P3      2       2       3       10      8       6

ATAT: 6.33
AWT : 3.33
```

Program (Priority Pre-emptive):

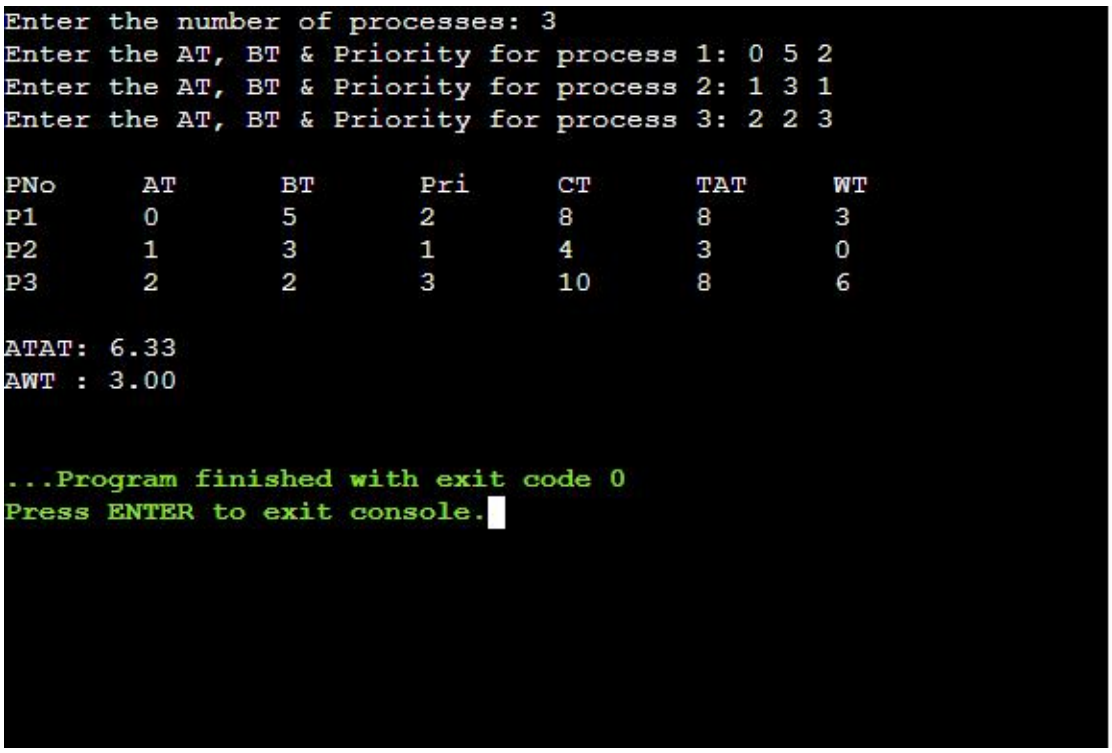
```
#include <stdio.h>
#include <stdbool.h>

// Lesser number means higher priority
struct priority {
   int pNo;
   int AT;
   int BT;
   int remain_BT;
   int priority;
   int CT;
   int TAT;
   int WT;
   bool completed;
};

void sort(struct priority arr[], int n) {
   struct priority temp;
   for (int i = 0; i < n; i++) {
      for (int j = i + 1; j < n; j++) {
         // Sort by arrival time
         if (arr[i].AT > arr[j].AT) {
            temp = arr[i];
            arr[i] = arr[j];
            arr[j] = temp;
         }
      }
   }
}
```

```
int findHighestPriority(struct priority arr[], int n, int
currentTime) {
   int highestPriorityIndex = -1;
   int highestPriority = 9999; // Assuming lower number
means higher priority

   for (int i = 0; i < n; i++) {
      if (!arr[i].completed && arr[i].AT <= currentTime &&
arr[i].priority < highestPriority) {
         highestPriority = arr[i].priority;
         highestPriorityIndex = i;
      }
   }

   return highestPriorityIndex;
}

int main() {
   int n, atat = 0, awt = 0, currentTime = 0;

   printf("Enter the number of processes: ");
   scanf("%d", &n);
   struct priority arr[n];

   for (int i = 0; i < n; i++) {
      arr[i].pNo = i + 1;
      printf("Enter the AT, BT & Priority for process %d: ",
i + 1);
      scanf("%d %d %d", &arr[i].AT, &arr[i].BT,
&arr[i].priority);
      arr[i].remain_BT = arr[i].BT;
```

```
        arr[i].completed = false;
    }

    sort(arr, n);

    int completedProcesses = 0;
    while (completedProcesses < n) {
        int highestPriorityIndex = findHighestPriority(arr, n,
currentTime);

        if (highestPriorityIndex == -1) {
            // No process available, CPU is idle
            printf("Idle time: %d -> %d\n", currentTime,
currentTime + 1);
            currentTime++;
        } else {
            // Execute the process for 1 unit of time
            arr[highestPriorityIndex].remain_BT--;
            currentTime++;

            if (arr[highestPriorityIndex].remain_BT == 0) {
                // Process completed
                arr[highestPriorityIndex].completed = true;
                arr[highestPriorityIndex].CT = currentTime;
                arr[highestPriorityIndex].TAT =
arr[highestPriorityIndex].CT -
arr[highestPriorityIndex].AT;
                arr[highestPriorityIndex].WT =
arr[highestPriorityIndex].TAT -
arr[highestPriorityIndex].BT;
```

```
            atat += arr[highestPriorityIndex].TAT;
            awt += arr[highestPriorityIndex].WT;

            completedProcesses++;
        }
    }
}

// Display results in short form
printf("\nPNo\tAT\tBT\tPri\tCT\tTAT\tWT\n");
for (int i = 0; i < n; i++) {
    printf("P%d\t%d\t%d\t%d\t%d\t%d\t%d\n",
        arr[i].pNo,
        arr[i].AT,
        arr[i].BT,
        arr[i].priority,
        arr[i].CT,
        arr[i].TAT,
        arr[i].WT);
}

// Display average times
printf("\nATAT: %.2f", (float)atat / n);
printf("\nAWT : %.2f\n", (float)awt / n);


return 0;
}
```

Output:


Enter the number of processes: 3
Enter the AT, BT & Priority for process 1: 0 5 2
Enter the AT, BT & Priority for process 2: 1 3 1
Enter the AT, BT & Priority for process 3: 2 2 3
PNo AT BT Pri CT TAT WT
P1 0 5 2 8 8 3
P2 1 3 1 4 3 0
P3 2 2 3 10 8 6
ATAT: 6.33
AWT : 3.00
...Program finished with exit code 0
Press ENTER to exit console.