

LAB-1

Write a C program to simulate the following non-pre-emptive CPU scheduling algorithm to find turnaround time and waiting time.

→FCFS

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

```
void main()
{
    int n;
    printf("Kshitiz Anand - 1BM22CS349");
    printf("Enter number of processes:\n");
    scanf("%d",&n);
    int pr[n], at[n], bt[n], ct[n], tat[n], wt[n];
    printf("Enter Process number:\n");
    for (int i=0; i<n; i++)
    {
        scanf("%d", &pr[i]);
    }
    printf("Enter Arrival Time:\n");
    for (int i=0; i<n; i++)
    {
        scanf("%d", &at[i]);
    }
    printf("Enter Burst Time:\n");
    for (int i=0; i<n; i++)
    {
        scanf("%d", &bt[i]);
    }
    int temp1, temp2, temp3;
    for (int i=0; i<n; i++)
    {
        for (int j=i+1; j<n; j++)
        {
            if (at[j]<at[i])
            {
                temp1 = at[j];
                at[j] = at[i];
                at[i] = temp1;

                temp2 = bt[j];
                bt[j] = bt[i];
                bt[i] = temp2;

                temp3 = pr[j];
                pr[j] = pr[i];
                pr[i] = temp3;
            }
        }
    }
    int x=at[0];
    for (int i=0; i<n; i++)
    {
```

```

    if (x<at[i])
    {
        x = at[i];
    }
    ct[i] = bt[i] + x;
    x = ct[i];
}
for (int i=0; i<n; i++)
{
    tat[i] = ct[i] - at[i];
}
for (int i=0; i<n; i++)
{
    wt[i] = tat[i] - bt[i];
}
for (int i=0; i<n; i++)
{
    printf("%d\t%d\t%d\t%d\t%d\t%d\n", pr[i], at[i], bt[i], ct[i], tat[i], wt[i]);
}
float avg_tat = 0, avg_wt = 0;
for (int i=0; i<n; i++)
{
    avg_tat = avg_tat + tat[i];
    avg_wt = avg_wt + wt[i];
}
avg_tat = avg_tat/n;
avg_wt = avg_wt/n;
printf("The average Turnaround time is: %f", avg_tat);
printf("\nThe average Waiting time is: %f", avg_wt);
}

```

```

Enter number of processes:
4
Enter Process number:
1
2
3
4
Enter Arrival Time:
0
1
5
6
Enter Burst Time:
2
2
3
4
1      0      2      2      2      0
2      1      2      4      3      1
3      5      3      8      3      0
4      6      4      12     6      2
The average Turnaround time is: 3.500000
The average Waiting time is: 0.750000`

```

→ SJF (pre-emptive)

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

```
// Function to find the waiting time, turnaround time, and completion time for all processes using SJF
(Preemptive)
```

```
void findCompletionTime(int processes[], int n, int bt[], int at[], int wt[], int tat[], int ct[])
```

```
{
```

```
    int remaining[n]; // Array to store remaining burst time of processes
```

```
    int currentTime = 0; // Current time
```

```
    int completed = 0; // Counter for completed processes
```

```
    // Initialize remaining array with burst times
```

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

```
        remaining[i] = bt[i];
```

```
    while (completed < n)
```

```
    {
```

```
        int shortest = -1; // Index of shortest remaining time process
```

```
        // Find process with shortest remaining burst time
```

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

```
        {
```

```
            if (at[i] <= currentTime && remaining[i] > 0)
```

```
            {
```

```
                if (shortest == -1 || remaining[i] <= remaining[shortest])
```

```
                    shortest = i;
```

```
            }
```

```
        }
```

```

    }

    // If no process found, move to next time
    if (shortest == -1)
    {
        currentTime++;
        continue;
    }

    // Reduce remaining time of the process
    remaining[shortest]--;

    // If the process is completed
    if (remaining[shortest] == 0)
    {
        completed++;
        // Set completion time for the process
        ct[shortest] = currentTime + 1;
        // Calculate waiting time and turnaround time for the process
        wt[shortest] = ct[shortest] - bt[shortest] - at[shortest];
        tat[shortest] = ct[shortest] - at[shortest];
    }

    // Move to the next time
    currentTime++;
}

// Print the table
for (int i = 0; i < n; i++)
{
    printf("%d\t%d\t%d\t%d\t%d\t%d\t%d\n", processes[i], at[i], bt[i], ct[i], tat[i], wt[i]);
}
float avg_tat = 0, avg_wt = 0;
for (int i = 0; i < n; i++)
{
    avg_tat += tat[i];
    avg_wt += wt[i];
}
avg_tat /= n;
avg_wt /= n;
printf("The average Turnaround time is %f\n", avg_tat);
printf("The average Waiting time is %f\n", avg_wt);
}

void main()
{
    // Number of processes
    int n;
    printf("Kshitiz Anand - 1BM22CS349");
    printf("Enter the number of processes: ");
    scanf("%d", &n);

    // Process id's
    int processes[n];
    // Burst time of all processes
    int burst_time[n];
    // Arrival time of all processes
    int arrival_time[n];

```

```

printf("Enter Process Number:\n");
for (int i = 0; i < n; i++)
{
    scanf("%d", &processes[i]);
}
printf("Enter Arrival Time:\n");
for (int i = 0; i < n; i++)
{
    scanf("%d", &arrival_time[i]);
}
printf("Enter Burst Time:\n");
for (int i = 0; i < n; i++)
{
    scanf("%d", &burst_time[i]);
}

// Arrays to store waiting time, turnaround time, and completion time
int wt[n], tat[n], ct[n];

printf("\nSJF (Preemptive) Scheduling:\n");
findCompletionTime(processes, n, burst_time, arrival_time, wt, tat, ct);
}

```

```

Enter the number of processes: 5
Enter Process Number:
1
2
3
4
5
Enter Arrival Time:
2
1
4
0
2
Enter Burst Time:
1
5
1
6
3

SJF (Preemptive) Scheduling:
1      2      1      3      1      0
2      1      5      16     15     10
3      4      1      5      1      0
4      0      6      11     11      5
5      2      3      7      5      2

The average Turnaround time is 6.600000
The average Waiting time is 3.400000

```

→ SJF (non-pre-emptive)

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

```

// Function to find the waiting time, turnaround time, response time, and completion time for all processes
using SJF (Non-preemptive)
void findCompletionTime(int processes[], int n, int bt[], int at[], int wt[], int tat[], int rt[], int ct[])

```

```

{
    int completion[n]; // Array to store completion times of processes
    int remaining[n]; // Array to store remaining burst time of processes

    // Initialize remaining array with burst times
    for (int i = 0; i < n; i++)
        remaining[i] = bt[i];

    int currentTime = 0; // Current time

    // Find process with shortest burst time
    for (int i = 0; i < n; i++)
    {
        int shortest = -1;
        for (int j = 0; j < n; j++)
        {
            if (at[j] <= currentTime && remaining[j] > 0)
            {
                if (shortest == -1 || remaining[j] < remaining[shortest])
                    shortest = j;
            }
        }

        if (shortest == -1)
        {
            currentTime++;
            continue;
        }

        // Set completion time for the process
        completion[shortest] = currentTime + remaining[shortest];
        // Update current time
        currentTime = completion[shortest];
        // Calculate waiting time, turnaround time, and response time for the process
        wt[shortest] = currentTime - bt[shortest] - at[shortest];
        tat[shortest] = currentTime - at[shortest];
        rt[shortest] = wt[shortest]; // Response time for non-preemptive SJF is the same as waiting time
        // Mark the process as completed
        remaining[shortest] = 0;
    }

    // Copy completion times to ct[] and print the table
    for (int i = 0; i < n; i++)
    {
        ct[i] = completion[i];
        printf("%d\t%d\t%d\t%d\t%d\t%d\t%d\t%d\n", processes[i], at[i], bt[i], ct[i], wt[i], tat[i], rt[i]);
    }

    float avg_tat = 0, avg_wt = 0;
    for (int i = 0; i < n; i++)
    {
        avg_tat += tat[i];
        avg_wt += wt[i];
    }

    avg_tat /= n;
    avg_wt /= n;
    printf("The average Turnaround time is %f\n", avg_tat);
    printf("The average Waiting time is %f\n", avg_wt);
}

```

```

}
void main()
{
    // Number of processes
    int n;
    printf("Kshitiz Anand - 1BM22CS349");
    printf("Enter the number of processes: ");
    scanf("%d", &n);

    // Process id's
    int processes[n];
    // Burst time of all processes
    int burst_time[n];
    // Arrival time of all processes
    int arrival_time[n];
    printf("Enter Process Number:\n");
    for (int i = 0; i < n; i++)
    {
        scanf("%d", &processes[i]);
    }
    printf("Enter Arrival Time:\n");
    for (int i = 0; i < n; i++)
    {
        scanf("%d", &arrival_time[i]);
    }
    printf("Enter Burst Time:\n");
    for (int i = 0; i < n; i++)
    {
        scanf("%d", &burst_time[i]);
    }
    // Arrays to store waiting time, turnaround time, response time, and completion time
    int wt[n], tat[n], rt[n], ct[n];

    // Initialize response times to -1
    for (int i = 0; i < n; i++)
        rt[i] = -1;
    printf("\nSJF (Non-preemptive) Scheduling:\n");
    findCompletionTime(processes, n, burst_time, arrival_time, wt, tat, rt, ct);
}

```

```

Enter the number of processes: 5
Enter Process Number:
1
2
3
4
5
Enter Arrival Time:
2
1
4
0
2
Enter Burst Time:
1
5
1
6
3

SJF (Non-preemptive) Scheduling:
1      2      1      7      4      5      4
2      1      5      16     10     15     10
3      4      1      8      3      4      3
4      0      6      6      0      6      0
5      2      3      11     6      9      6

The average Turnaround time is 7.800000
The average Waiting time is 4.600000

```

LAB-2

Write a C program to simulate the following CPU scheduling algorithm to find turnaround time and waiting time.

→ Priority (pre-emptive & non-pre-emptive)

```
#include <stdio.h>

#include <stdbool.h>

// Function to find the waiting time, turnaround time, and completion time for all processes using Priority Scheduling (Preemptive)

void findCompletionTime(int processes[], int n, int bt[], int at[], int wt[], int tat[], int ct[], int rt[], int priority[], bool isLowerPriorityHigher)
{
    int remaining[n]; // Array to store remaining burst time of processes
    int currentTime = 0; // Current time
    int completed = 0; // Counter for completed processes
    bool isFinished[n]; // Array to indicate if the process is finished
    // Initialize remaining array with burst times and set response times
    for (int i = 0; i < n; i++) {
        remaining[i] = bt[i];
        isFinished[i] = false;
        rt[i] = -1; // Response time is initially unset
    }
    while (completed < n) {
        int highestPriorityIndex = -1;
        int highestPriority = isLowerPriorityHigher ? 1000000 : -1; // Adjust initial value based on priority type

        // Find the process with the highest priority that has arrived and is not finished
        for (int i = 0; i < n; i++) {
            if (at[i] <= currentTime && !isFinished[i] &&
                ((isLowerPriorityHigher && priority[i] < highestPriority) ||
                 (!isLowerPriorityHigher && priority[i] > highestPriority))) {
                highestPriority = priority[i];
                highestPriorityIndex = i;
            }
        }
    }
}
```



```

    }    }

// If no process is found, move to the next time
if (highestPriorityIndex == -1) {
    currentTime++;
    continue;
}

int currentProcess = highestPriorityIndex;

// Set response time if it's the first time the process is executed
if (rt[currentProcess] == -1) {
    rt[currentProcess] = currentTime - at[currentProcess];
}

// Execute the process for 1 unit of time
remaining[currentProcess]--;
currentTime++;

// If the process is completed
if (remaining[currentProcess] == 0) {
    isFinished[currentProcess] = true;
    completed++;

    ct[currentProcess] = currentTime; // Set completion time for the process
    tat[currentProcess] = ct[currentProcess] - at[currentProcess]; // Calculate turnaround time
    wt[currentProcess] = tat[currentProcess] - bt[currentProcess]; // Calculate waiting time
} }

// Print the table
printf("Process\tArrival Time\tBurst Time\tPriority\tCompletion Time\tTurnaround Time\tWaiting Time\tResponse Time\n");

for (int i = 0; i < n; i++) {
    printf("%d\t%d\t%d\t%d\t%d\t%d\t%d\t%d\n",
           processes[i], at[i], bt[i], priority[i], ct[i], tat[i], wt[i], rt[i]);
}

void main()
{
    // Number of processes

```

```

int n;
printf("Kshitiz Anand - 1BM22CS349");

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


// Process id's
int processes[n];

// Burst time of all processes
int burst_time[n];

// Arrival time of all processes
int arrival_time[n];

// Priority of all processes
int priority[n];

// Priority type (true for lower number = higher priority, false for higher number = higher priority)
int priorityType;

bool isLowerPriorityHigher;

printf("Enter 1 if lower number indicates higher priority, 0 if higher number indicates higher priority: ");
scanf("%d", &priorityType);

isLowerPriorityHigher = (priorityType == 1);


printf("Enter Process Number:\n");
for (int i = 0; i < n; i++) {
    scanf("%d", &processes[i]);
}

printf("Enter Priority:\n");
for (int i = 0; i < n; i++) {
    scanf("%d", &priority[i]);
}

printf("Enter Arrival Time:\n");
for (int i = 0; i < n; i++) {
    scanf("%d", &arrival_time[i]);
}

printf("Enter Burst Time:\n");
for (int i = 0; i < n; i++) {

```

```

        scanf("%d", &burst_time[i]);
    }

    // Arrays to store waiting time, turnaround time, completion time, and response time
    int wt[n], tat[n], ct[n], rt[n];

    printf("\nPriority Scheduling (Preemptive):\n");

    findCompletionTime(processes, n, burst_time, arrival_time, wt, tat, ct, rt, priority, isLowerPriorityHigher);
}

```

Priority Scheduling (Preemptive):									
Process	Arrival Time	Burst Time	Priority	Completion Time	Turnaround Time	Waiting Time	Response Time		
1	0	8	3	20	20	12	0		
2	1	2	4	3	2	0	0		
3	3	4	4	13	10	6	0		
4	4	1	5	5	1	0	0		
5	5	6	2	26	21	15	15		
6	6	5	6	11	5	0	0		
7	10	1	1	27	17	16	16		

Process returned 7 (0x7) execution time : 51.253 s

→Round Robin (Experiment with different quantum sizes for RR algorithm)

```

#include <stdio.h>

#include <stdbool.h>

void findCompletionTime(int processes[], int n, int bt[], int at[], int wt[], int tat[], int ct[], int rt[], int quantum)
{
    int remaining[n]; // Array to store remaining burst time of processes
    bool firstResponse[n]; // Array to track if response time has been set
    int currentTime = 0; // Current time
    int completed = 0; // Counter for completed processes

    // Initialize remaining array with burst times and first response array
    for (int i = 0; i < n; i++) {
        remaining[i] = bt[i];
        firstResponse[i] = true;
    }

    // Queue to hold the indices of the processes
    int queue[n];

    int front = -1, rear = -1;

    // Function to add process to the queue
    void enqueue(int process) {
        if (rear == n - 1)

```

```

    rear = -1;
    queue[++rear] = process;
    if (front == -1)
        front = 0;}

// Function to remove process from the queue
int dequeue() {
    int process = queue[front];
    if (front == rear)
        front = rear = -1;
    else {
        front++;
        if (front == n)
            front = 0;
    }    return process;
}

// To track which processes have been added to the queue
bool inQueue[n];
for (int i = 0; i < n; i++)
    inQueue[i] = false;
while (completed < n) {
    // Add all processes to the queue that have arrived by the current time
    for (int i = 0; i < n; i++) {
        if (at[i] <= currentTime && !inQueue[i]) {
            enqueue(i);
            inQueue[i] = true;
        }    }
    // If no process is ready, increment the current time
    if (front == -1) {
        currentTime++;
        continue;    }
    int currentProcess = dequeue();
    // Set response time if it's the first time the process is executed
    if (firstResponse[currentProcess]) {

```

```

    rt[currentProcess] = currentTime - at[currentProcess];
    firstResponse[currentProcess] = false;
}
// Execute the process for the time quantum or until completion
if (remaining[currentProcess] > quantum) {
    remaining[currentProcess] -= quantum;
    currentTime += quantum;
} else {
    currentTime += remaining[currentProcess];
    remaining[currentProcess] = 0;
    completed++;
    // Set completion time for the process
    ct[currentProcess] = currentTime;
    // Calculate waiting time and turnaround time for the process
    tat[currentProcess] = ct[currentProcess] - at[currentProcess];
    wt[currentProcess] = tat[currentProcess] - bt[currentProcess];
}
// Add all processes to the queue that have arrived by the current time
for (int i = 0; i < n; i++) {
    if (at[i] <= currentTime && !inQueue[i]) {
        enqueue(i);
        inQueue[i] = true;
    }
}
// Re-enqueue the current process if it is not finished
if (remaining[currentProcess] > 0) {
    enqueue(currentProcess);
}
}
// Print the table
printf("Process\tArrival Time\tBurst Time\tCompletion Time\tTurnaround Time\tWaiting Time\tResponse Time\n");
for (int i = 0; i < n; i++) {
    printf("%d\t%d\t%d\t%d\t%d\t%d\t%d\n",
        processes[i], at[i], bt[i], ct[i], tat[i], wt[i], rt[i]);
}

```

```

    }}

void main()
{
    // Number of processes

    int n;

    printf("Kshitiz Anand - 1BM22CS349");
    printf("Enter the number of processes: ");

    scanf("%d", &n);

    // Process id's

    int processes[n];

    // Burst time of all processes

    int burst_time[n];

    // Arrival time of all processes

    int arrival_time[n];

    printf("Enter Process Number:\n");
    for (int i = 0; i < n; i++) {
        scanf("%d", &processes[i]);
    }

    printf("Enter Arrival Time:\n");
    for (int i = 0; i < n; i++) {
        scanf("%d", &arrival_time[i]);
    }

    printf("Enter Burst Time:\n");
    for (int i = 0; i < n; i++) {
        scanf("%d", &burst_time[i]);
    }


    // Time quantum for Round Robin

    int quantum;

    printf("Enter the time quantum: ");

    scanf("%d", &quantum);

    // Arrays to store waiting time, turnaround time, completion time, and response time

    int wt[n], tat[n], ct[n], rt[n];

    printf("\nRound Robin Scheduling:\n");

```

```
    findCompletionTime(processes, n, burst_time, arrival_time, wt, tat, ct, rt, quantum);  
}
```

Round Robin Scheduling:						
Process	Arrival Time	Burst Time	Completion Time	Turnaround Time	Waiting Time	Response Time
1	0	5	13	13	8	0
2	1	3	12	11	8	1
3	2	1	5	3	2	2
4	3	2	9	6	4	4
5	4	3	14	10	7	5