OS Lab: 8, 9, 10, 11

Department of Computer Science

Iqra University Islamabad

Operating System

Maqsood Ahmed

ID: 38186

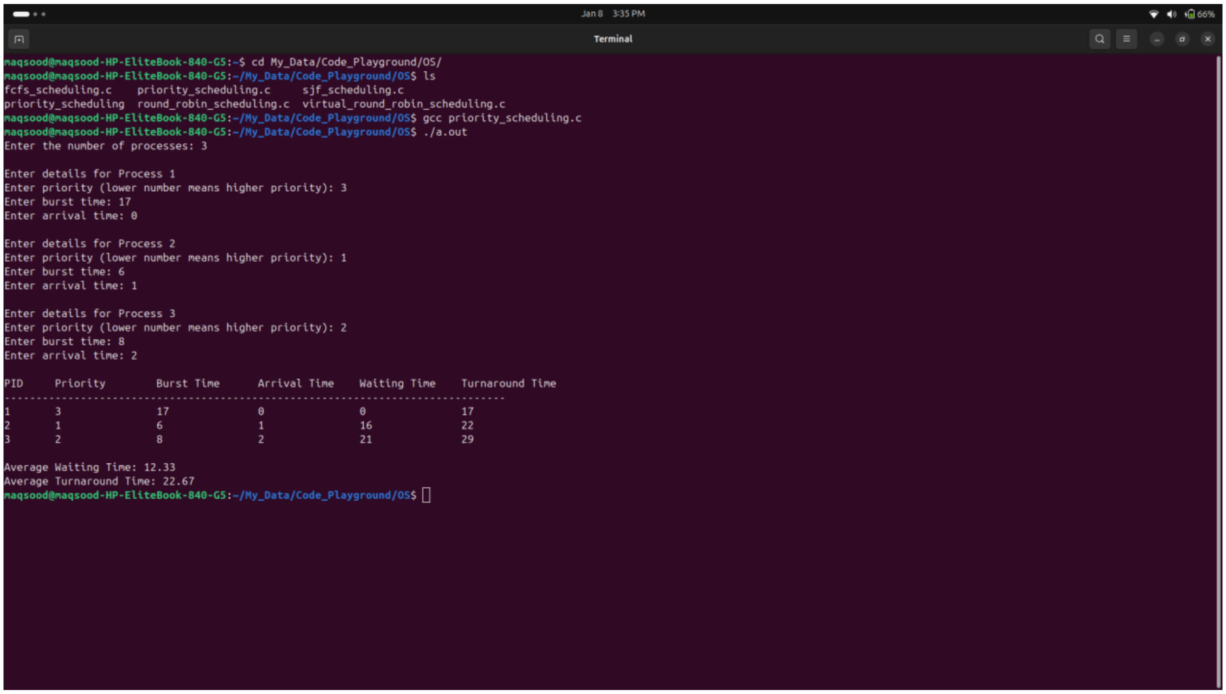
Lab: 08

To write a C program for implementation of Priority scheduling algorithms.

Source Code:

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

// Structure to represent a process
struct Process {
    int pid;           // Process ID
    int priority;      // Priority of the process
    int burstTime;     // Burst time of the process
    int arrivalTime;   // Arrival time of the process
    int waitingTime;   // Waiting time of the process
    int turnAroundTime; // Turnaround time of the process
    bool isCompleted;  // Flag to check if the process is completed
};

// Function to find the next process to schedule based on priority and arrival time
int findNextProcess(struct Process p[], int n, int currentTime) {
    int minPriority = 100000, nextProcessIndex = -1;
    for (int i = 0; i < n; i++) {
        if (!p[i].isCompleted && p[i].arrivalTime <= currentTime) {
            if (p[i].priority < minPriority) {
                minPriority = p[i].priority;
                nextProcessIndex = i;
            }
        }
    }
    return nextProcessIndex;
}

// Function to calculate waiting and turnaround times
void calculateTimes(struct Process p[], int n) {
    int currentTime = 0, completed = 0;

    while (completed < n) {
        int idx = findNextProcess(p, n, currentTime);
        if (idx == -1) {
            currentTime++; // If no process is ready, increment time
            continue;
        }

        // Schedule the process
        currentTime += p[idx].burstTime;
        p[idx].waitingTime = currentTime - p[idx].arrivalTime - p[idx].burstTime;
        if (p[idx].waitingTime < 0) p[idx].waitingTime = 0; // No negative waiting time
        p[idx].turnAroundTime = currentTime - p[idx].arrivalTime;
        p[idx].isCompleted = true;
        completed++;
    }
}

// Function to calculate average waiting and turnaround times
void calculateAverages(struct Process p[], int n, float *avgWait, float *avgTurnAround) {
    int totalWait = 0, totalTurnAround = 0;
    for (int i = 0; i < n; i++) {
        totalWait += p[i].waitingTime;
        totalTurnAround += p[i].turnAroundTime;
    }
    *avgWait = (float)totalWait / n;
    *avgTurnAround = (float)totalTurnAround / n;
}

// Function to display the process information
void displayProcesses(struct Process p[], int n) {
    printf("\nPID\tPriority\tBurst Time\tArrival Time\tWaiting Time\tTurnaround Time\n");
    printf("--------------------------------------------------------------------------------\n");
    for (int i = 0; i < n; i++) {
        printf("%d\t%d\t\t%d\t\t%d\t\t%d\t\t%d\n",
                p[i].pid, p[i].priority, p[i].burstTime, p[i].arrivalTime,
                p[i].waitingTime, p[i].turnAroundTime);
    }
}

// Main function
int main() {
    int n;
    float avgWait, avgTurnAround;

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

    struct Process processes[n];

    // Input: Process details
    for (int i = 0; i < n; i++) {
        printf("\nEnter details for Process %d\n", i + 1);
        processes[i].pid = i + 1;
        printf("Enter priority (lower number means higher priority): ");
        scanf("%d", &processes[i].priority);
        printf("Enter burst time: ");
        scanf("%d", &processes[i].burstTime);
        printf("Enter arrival time: ");
        scanf("%d", &processes[i].arrivalTime);
        processes[i].isCompleted = false; // Mark process as not completed
    }

    // Step 1: Calculate times
    calculateTimes(processes, n);

    // Step 2: Calculate averages
    calculateAverages(processes, n, &avgWait, &avgTurnAround);
    // Step 3: Display processes and metrics
    displayProcesses(processes, n);

    // Step 4: Display average waiting and turnaround times
    printf("\nAverage Waiting Time: %.2f\n", avgWait);
    printf("Average Turnaround Time: %.2f\n", avgTurnAround);

    return 0;
}
```

OUTPUT:



```
maqsood@maqsood-HP-EliteBook-840-G5:~$ cd My_Data/Code_Playground/OS/
maqsood@maqsood-HP-EliteBook-840-G5:~/My_Data/Code_Playground/OS$ ls
fcfs_scheduling.c    priority_scheduling.c     sjf_scheduling.c
priority_scheduling  round_robin_scheduling.c  virtual_round_robin_scheduling.c
maqsood@maqsood-HP-EliteBook-840-G5:~/My_Data/Code_Playground/OS$ gcc priority_scheduling.c
maqsood@maqsood-HP-EliteBook-840-G5:~/My_Data/Code_Playground/OS$ ./a.out
Enter the number of processes: 3

Enter details for Process 1
Enter priority (lower number means higher priority): 3
Enter burst time: 17
Enter arrival time: 0

Enter details for Process 2
Enter priority (lower number means higher priority): 1
Enter burst time: 6
Enter arrival time: 1

Enter details for Process 3
Enter priority (lower number means higher priority): 2
Enter burst time: 8
Enter arrival time: 2

PID     Priority        Burst Time      Arrival Time    Waiting Time    Turnaround Time
-------------------------------------------------------------------------------
1       3               17              0               0               17
2       1               6               1               16              22
3       2               8               2               21              29

Average Waiting Time: 12.33
Average Turnaround Time: 22.67
maqsood@maqsood-HP-EliteBook-840-G5:~/My_Data/Code_Playground/OS$ 
```

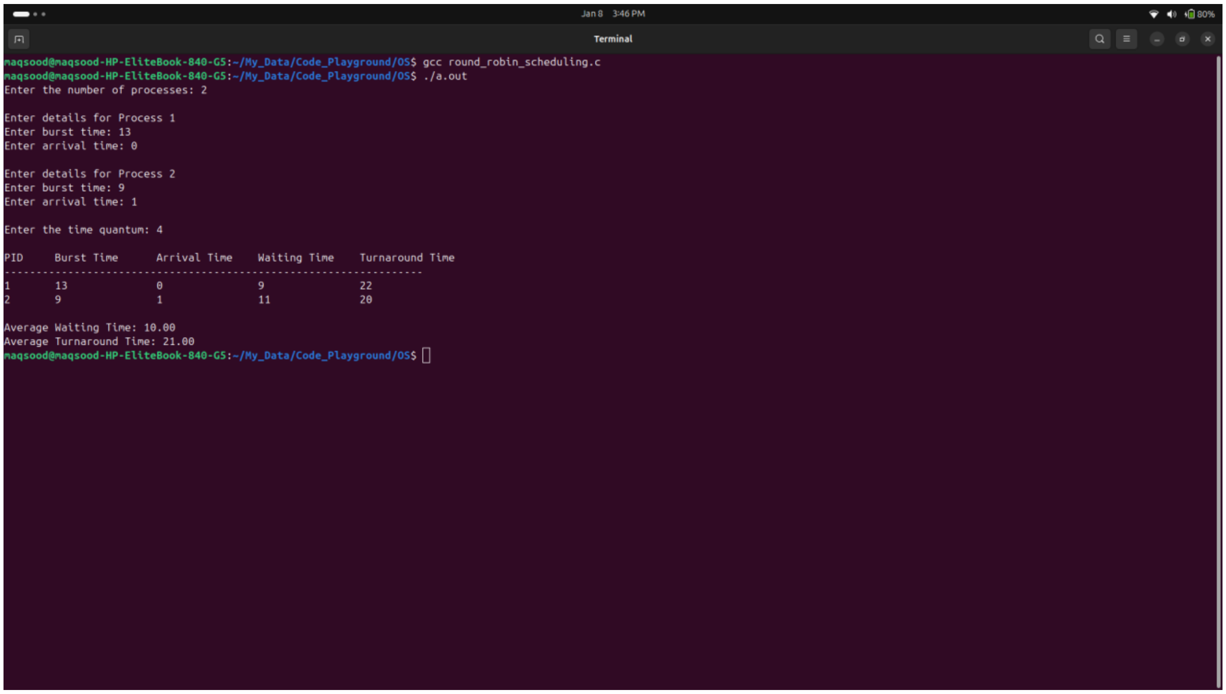
Lab: 09

To write a C program for implementation of Round Robin scheduling algorithm.

Source Code:

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

// Structure to represent a process
struct Process {
    int pid;           // Process ID
    int burstTime;      // Burst time of the process
    int remainingTime;  // Remaining time of the process
    int arrivalTime;    // Arrival time of the process
    int waitingTime;    // Waiting time of the process
    int turnAroundTime; // Turnaround time of the process
};

// Function to calculate waiting and turnaround times using Round Robin
void calculateTimes(struct Process p[], int n, int timeQuantum) {
    int currentTime = 0, completed = 0;
    bool processCompleted[n]; // Array to track completed processes
    for (int i = 0; i < n; i++) processCompleted[i] = false;

    while (completed < n) {
        bool found = false;

        for (int i = 0; i < n; i++) {
            if (p[i].remainingTime > 0 && p[i].arrivalTime <= currentTime) {
                found = true;

                if (p[i].remainingTime > timeQuantum) {
                    // Execute for a time quantum
                    currentTime += timeQuantum;
                    p[i].remainingTime -= timeQuantum;
                } else {
                    // Execute for remaining time and mark as complete
                    currentTime += p[i].remainingTime;
                    p[i].remainingTime = 0;

                    // Calculate turnaround and waiting times
                    p[i].turnAroundTime = currentTime - p[i].arrivalTime;
                    p[i].waitingTime = p[i].turnAroundTime - p[i].burstTime;

                    if (p[i].waitingTime < 0) p[i].waitingTime = 0;
                    processCompleted[i] = true;
                    completed++;
                }
            }
        }

        // If no process was ready, increment time
        if (!found) currentTime++;
    }
}

// Function to calculate average waiting and turnaround times
void calculateAverages(struct Process p[], int n, float *avgWait, float *avgTurnAround) {
    int totalWait = 0, totalTurnAround = 0;
    for (int i = 0; i < n; i++) {
        totalWait += p[i].waitingTime;
        totalTurnAround += p[i].turnAroundTime;
    }
    *avgWait = (float)totalWait / n;
    *avgTurnAround = (float)totalTurnAround / n;
}

// Function to display the process information
void displayProcesses(struct Process p[], int n) {
    printf("\nPID\tBurst Time\tArrival Time\tWaiting Time\tTurnaround Time\n");
    printf("------------------------------------------------------------\n");
    for (int i = 0; i < n; i++) {
        printf("%d\t%d\t\t%d\t\t%d\t\t%d\n",
               p[i].pid, p[i].burstTime, p[i].arrivalTime,
               p[i].waitingTime, p[i].turnAroundTime);
    }
}

// Main function
int main() {
    int n, timeQuantum;
    float avgWait, avgTurnAround;

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

    struct Process processes[n];

    // Input: Process details
    for (int i = 0; i < n; i++) {
        printf("\nEnter details for Process %d\n", i + 1);
        processes[i].pid = i + 1;
        printf("Enter burst time: ");
        scanf("%d", &processes[i].burstTime);
        printf("Enter arrival time: ");
        scanf("%d", &processes[i].arrivalTime);
        processes[i].remainingTime = processes[i].burstTime; // Initialize remaining time
    }

    // Input: Time Quantum
    printf("\nEnter the time quantum: ");
    scanf("%d", &timeQuantum);

    // Step 1: Calculate times
    calculateTimes(processes, n, timeQuantum);

    // Step 2: Calculate averages
    calculateAverages(processes, n, &avgWait, &avgTurnAround);

    // Step 3: Display processes and metrics
    displayProcesses(processes, n);

    // Step 4: Display average waiting and turnaround times
    printf("\nAverage Waiting Time: %.2f\n", avgWait);
    printf("Average Turnaround Time: %.2f\n", avgTurnAround);

    return 0;
}
```

OUTPUT:



```
maqsood@maqsood-HP-EliteBook-840-G5:~/My_Data/Code_Playground/OS$ gcc round_robin_scheduling.c
maqsood@maqsood-HP-EliteBook-840-G5:~/My_Data/Code_Playground/OS$ ./a.out
Enter the number of processes: 2

Enter details for Process 1
Enter burst time: 13
Enter arrival time: 0

Enter details for Process 2
Enter burst time: 9
Enter arrival time: 1

Enter the time quantum: 4

PID     Burst Time      Arrival Time    Waiting Time    Turnaround Time
-----------------------------------------------------------------
1       13              0               9               22
2       9               1               11              20

Average Waiting Time: 10.00
Average Turnaround Time: 21.00
maqsood@maqsood-HP-EliteBook-840-G5:~/My_Data/Code_Playground/OS$ 
```

Lab: 10

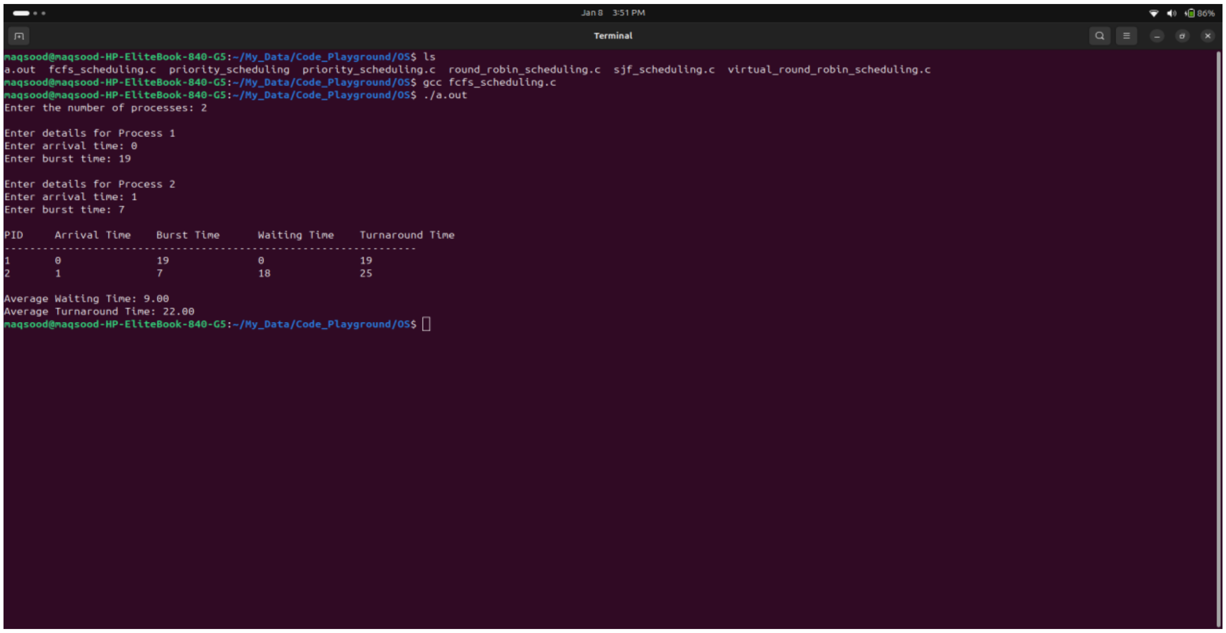
To write a C program for implementation of FCFS scheduling algorithms.

Source Code:

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

// Structure to represent a process
struct Process {
    int pid;          // Process ID
    int burstTime;     // Burst time of the process
    int arrivalTime;   // Arrival time of the process
    int waitingTime;   // Waiting time of the process
    int turnAroundTime; // Turnaround time of the process
};

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

// Function to calculate waiting and turnaround times
```

```
void calculateTimes(struct Process p[], int n) {
    int currentTime = 0;

    for (int i = 0; i < n; i++) {
        if (currentTime < p[i].arrivalTime) {
            currentTime = p[i].arrivalTime; // Wait for the process to arrive
        }
        p[i].waitingTime = currentTime - p[i].arrivalTime;
        currentTime += p[i].burstTime;
        p[i].turnAroundTime = p[i].waitingTime + p[i].burstTime;
    }
}

// Function to calculate average waiting and turnaround times
void calculateAverages(struct Process p[], int n, float *avgWait, float *avgTurnAround) {
    int totalWait = 0, totalTurnAround = 0;
    for (int i = 0; i < n; i++) {
        totalWait += p[i].waitingTime;
        totalTurnAround += p[i].turnAroundTime;
    }
    *avgWait = (float)totalWait / n;
    *avgTurnAround = (float)totalTurnAround / n;
}

// Function to display the process information
void displayProcesses(struct Process p[], int n) {
    printf("\nPID\tBurst Time\tArrival Time\tWaiting Time\tTurnaround Time\n");
    printf("----------------------------------------------------------------\n");
    for (int i = 0; i < n; i++) {
        printf("%d\t%d\t\t%d\t\t%d\t\t%d\n",
               p[i].pid, p[i].burstTime, p[i].arrivalTime,
               p[i].waitingTime, p[i].turnAroundTime);
    }
}

// Main function
int main() {
    int n;
    float avgWait, avgTurnAround;

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

    struct Process processes[n];

    // Input: Process details
    for (int i = 0; i < n; i++) {
        printf("\nEnter details for Process %d\n", i + 1);
        processes[i].pid = i + 1;
        printf("Enter burst time: ");
        scanf("%d", &processes[i].burstTime);
        printf("Enter arrival time: ");
        scanf("%d", &processes[i].arrivalTime);
    }
    // Step 1: Sort by arrival time
    sortByArrivalTime(processes, n);

    // Step 2: Calculate times
    calculateTimes(processes, n);

    // Step 3: Calculate averages
    calculateAverages(processes, n, &avgWait, &avgTurnAround);

    // Step 4: Display processes and metrics
    displayProcesses(processes, n);

    // Step 5: Display average waiting and turnaround times
    printf("\nAverage Waiting Time: %.2f\n", avgWait);
    printf("Average Turnaround Time: %.2f\n", avgTurnAround);

    return 0;
}
```

OUTPUT:



```
maqsood@maqsood-HP-EliteBook-840-G5:~/My_Data/Code_Playground/OS$ ls
a.out  fcfs_scheduling.c  priority_scheduling  priority_scheduling.c  round_robin_scheduling.c  sjf_scheduling.c  virtual_round_robin_scheduling.c
maqsood@maqsood-HP-EliteBook-840-G5:~/My_Data/Code_Playground/OS$ gcc fcfs_scheduling.c
maqsood@maqsood-HP-EliteBook-840-G5:~/My_Data/Code_Playground/OS$ ./a.out
Enter the number of processes: 2

Enter details for Process 1
Enter arrival time: 0
Enter burst time: 19

Enter details for Process 2
Enter arrival time: 1
Enter burst time: 7

PID     Arrival Time    Burst Time      Waiting Time    Turnaround Time
-----------------------------------------------------------------
1       0               19              0               19
2       1               7               18              25

Average Waiting Time: 9.00
Average Turnaround Time: 22.00
maqsood@maqsood-HP-EliteBook-840-G5:~/My_Data/Code_Playground/OS$ 
```

Lab: 11

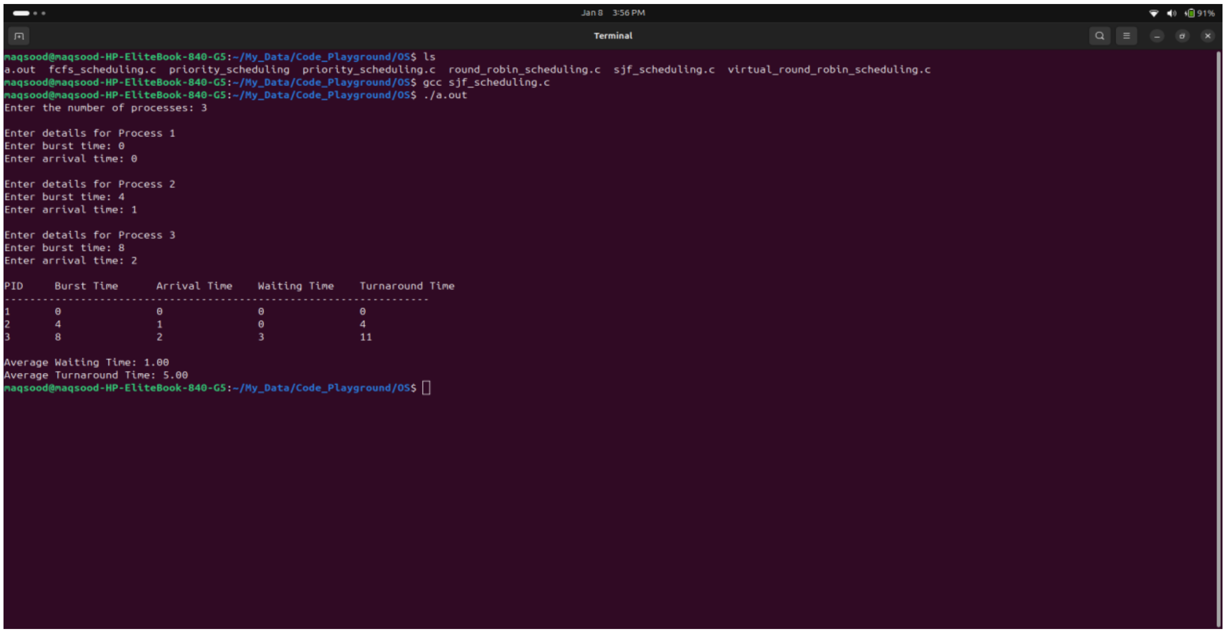
To write a C program for implementation of FCFS scheduling algorithms.

Source Code:

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

// Structure to represent a process
```

```
struct Process {
    int pid;           // Process ID
    int burstTime;     // Burst time of the process
    int arrivalTime;   // Arrival time of the process
    int waitingTime;   // Waiting time of the process
    int turnAroundTime; // Turnaround time of the process
    bool isCompleted;  // Flag to check if the process is completed
};

// Function to find the next process to execute
int findNextProcess(struct Process p[], int n, int currentTime) {
    int shortestJobIndex = -1;
    int minBurstTime = 100000; // A large number to compare

    for (int i = 0; i < n; i++) {
        if (!p[i].isCompleted && p[i].arrivalTime <= currentTime) {
            if (p[i].burstTime < minBurstTime) {
                minBurstTime = p[i].burstTime;
                shortestJobIndex = i;
            }
        }
    }

    return shortestJobIndex;
}

// Function to calculate waiting and turnaround times
void calculateTimes(struct Process p[], int n) {
    int currentTime = 0, completed = 0;

    while (completed < n) {
        int idx = findNextProcess(p, n, currentTime);

        if (idx == -1) {
            currentTime++; // If no process is ready, increment time
            continue;
        }

        // Execute the shortest job
        currentTime += p[idx].burstTime;
        p[idx].waitingTime = currentTime - p[idx].arrivalTime - p[idx].burstTime;
        if (p[idx].waitingTime < 0) p[idx].waitingTime = 0; // No negative waiting time
        p[idx].turnAroundTime = currentTime - p[idx].arrivalTime;
        p[idx].isCompleted = true;
        completed++;
    }
}

// Function to calculate average waiting and turnaround times
void calculateAverages(struct Process p[], int n, float *avgWait, float *avgTurnAround) {
    int totalWait = 0, totalTurnAround = 0;
    for (int i = 0; i < n; i++) {
        totalWait += p[i].waitingTime;
        totalTurnAround += p[i].turnAroundTime;
    }
    *avgWait = (float)totalWait / n;
    *avgTurnAround = (float)totalTurnAround / n;
}

// Function to display the process information
void displayProcesses(struct Process p[], int n) {
    printf("\nPID\tBurst Time\tArrival Time\tWaiting Time\tTurnaround Time\n");
    printf("----------------------------------------------------------------\n");
    for (int i = 0; i < n; i++) {
        printf("%d\t%d\t\t%d\t\t%d\t\t%d\n",
               p[i].pid, p[i].burstTime, p[i].arrivalTime,
               p[i].waitingTime, p[i].turnAroundTime);
    }
}

// Main function
int main() {
    int n;
    float avgWait, avgTurnAround;

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

    struct Process processes[n];

    // Input: Process details
    for (int i = 0; i < n; i++) {
        printf("\nEnter details for Process %d\n", i + 1);
        processes[i].pid = i + 1;
        printf("Enter burst time: ");
        scanf("%d", &processes[i].burstTime);
        printf("Enter arrival time: ");
        scanf("%d", &processes[i].arrivalTime);
        processes[i].isCompleted = false; // Mark process as not completed
    }

    // Step 1: Calculate times
    calculateTimes(processes, n);

    // Step 2: Calculate averages
    calculateAverages(processes, n, &avgWait, &avgTurnAround);

    // Step 3: Display processes and metrics
    displayProcesses(processes, n);

    // Step 4: Display average waiting and turnaround times
    printf("\nAverage Waiting Time: %.2f\n", avgWait);
    printf("Average Turnaround Time: %.2f\n", avgTurnAround);

    return 0;
}
```

OUTPUT:



```
maqsood@maqsood-HP-EliteBook-840-G5:~/My_Data/Code_Playground/OS$ ls
a.out  fcfs_scheduling.c  priority_scheduling  priority_scheduling.c  round_robin_scheduling.c  sjf_scheduling.c  virtual_round_robin_scheduling.c
maqsood@maqsood-HP-EliteBook-840-G5:~/My_Data/Code_Playground/OS$ gcc sjf_scheduling.c
maqsood@maqsood-HP-EliteBook-840-G5:~/My_Data/Code_Playground/OS$ ./a.out
Enter the number of processes: 3

Enter details for Process 1
Enter burst time: 0
Enter arrival time: 0

Enter details for Process 2
Enter burst time: 4
Enter arrival time: 1

Enter details for Process 3
Enter burst time: 8
Enter arrival time: 2

PID     Burst Time      Arrival Time    Waiting Time    Turnaround Time
------------------------------------------------------------------
1       0               0               0               0
2       4               1               0               4
3       8               2               3               11

Average Waiting Time: 1.00
Average Turnaround Time: 5.00
maqsood@maqsood-HP-EliteBook-840-G5:~/My_Data/Code_Playground/OS$ 
```

The End