SSN COLLEGE OF ENGINEERING, KALAVAKKAM
(An Autonomous Institution, Affiliated to Anna University, Chennai)

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

UCS1411 - OPERATING SYSTEMS LAB

LAB EXERCISE 4

Implementation of CPU Scheduling Policies

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Develop a menu driven C program to implement the CPU Scheduling Algorithms

1. Priority (Non-Preemptive and Preemptive)
2. Round Robin

Algorithm for Priority Preemptive:

```
1) Get total no of process from the user.
2) Get process id, arrival time, burst time, priority for all process.
3) Take a temporary burst time(rem_time) to have a value of remining burst time of all
   the process
4) Have count of completed process, current time.
5) Loop until completed less than total no of process
     a) Compare priority of current running job and new entering job at that current
        time
     b) If priority is greater then stop the current processor and update rem_time and
        begin the new process
     c) Else continue until the process ends
     d) While the process ends set completion time as current time, waiting time as
        completion time minus sum of arrival time and burst time, turnaround time as
        sum of waiting time and burst time, update total turnaround time and total
        waiting time
6) Calculate average waiting time by dividing total waiting time by total no of process
7) Calculate average turnaround time by dividing total turnaround time by total no of
   process
8) Print process table
9) Print Gantt Chart
```

Algorithm for Round Robin:

```
1) Get total no of process, time quantum from the user.
```

2) Get process id, arrival time, burst time for all process.
3) Take a temporary burst time(rem_time) to have a value of remining burst time of all the process
4) Sort the process based on arrival time.
5) Have count of completed process, current time.
6) Loop until all process ends
    a) If rem_time is less than or equal to quantum then current time is sum of current time and burst time of the process and set turnaround time as current time minus arrival time, waiting time as current time minus sum of arrival time and burst time, update total turnaround time and total waiting time
    b) Else update rem_time as rem_time minus quantum and current time is sum of current time and quantum
7) Calculate average waiting time by dividing total waiting time by total no of process
8) Calculate average turnaround time by dividing total turnaround time by total no of process
9) Print process table
10) Print Gantt Chart

Code:

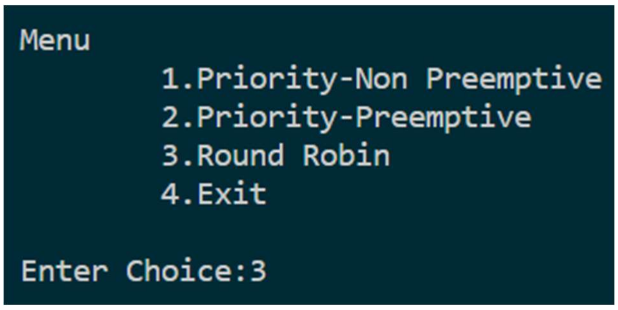
```c
/*Develop a menu driven C program to implement the CPU Scheduling Algorithms - Priority
(Non-Preemptive and Preemptive) and Round Robin
Algorithm: 1. Read the following a. Number of p b. Process IDs c. Arrival time for each
process d. Burst Time for each process 2. Design a menu with FCFSand SJFoptions 3. Upon
selection of menu option apply the corresponding algorithm. 4. Compute the Turnaround
Time, Average waiting Time for each of the algorithm. 5. Tabularize the results. 6.
Display the Gantt Chart.*/

#include <stdio.h>
#include <stdlib.h>
#include <fcntl.h>
#include <string.h>

typedef struct process
{
    char pid[3];
    int arrival, burst,teempburst, turnaround, waiting, completion, priority;
} process;

void print_gantt_chart(process p[], int n)
{
    printf("\n\nGantt-Chart\n");
    int i, j;
    printf(" ");
    for (i = 0; i < n; i++)
    {
        for (j = 0; j < p[i].burst; j++)
            printf("--");
        printf(" ");
    }
    printf("\n|");
    for (i = 0; i < n; i++)
    {
        for (j = 0; j < p[i].burst - 1; j++)
            printf(" ");
        printf("P%s", p[i].pid);
        for (j = 0; j < p[i].burst - 1; j++)
            printf(" ");
        printf("|");
    }
    printf("\n ");
    for (i = 0; i < n; i++)
    {
        for (j = 0; j < p[i].burst; j++)
            printf("--");
        printf(" ");
    }
    printf("\n");

    printf("0");
    for (i = 0; i < n; i++)
    {
        for (j = 0; j < p[i].burst; j++)
            printf("  ");
        if (p[i].turnaround > 9)
            printf("\b");
        printf("%d", p[i].turnaround);
    }
    printf("\n");
}

int main()
{
    int no_of_process;
    int totalwaitingtime = 0, totalturnaround = 0;
    int pos;
    char ch = 'y';
    process p[100];
    while (ch == 'y' || ch == 'Y')
    {
        int choice;
        printf("\nMenu\n\t1.Priority-Non Preemptive\n\t2.Priority-Preemptive\n\t3.Round
Robin\n\t4.Exit\n\t\nEnter Choice:");
        scanf(" %d", &choice);
        switch (choice)
        {
        case 1:
        {
            printf("\nPriority-Non Preemptive\n");
            int no_of_process;
            printf("\nNumber of p :");
            scanf(" %d", &no_of_process);
            for (int i = 0; i < no_of_process; i++)
            {
                printf("\n\nProcess %d\n", i + 1);
                printf("Process ID: ");
                scanf(" %s", p[i].pid);
                printf("Burst Time :");
                scanf(" %d", &p[i].burst);
                printf("Priority :");
                scanf(" %d", &p[i].priority);
            }

            process temppro;
            for (int i = 0; i < no_of_process; i++)
            {
                pos = i;
                for (int j = i + 1; j < no_of_process; j++)
                {
                    if (p[j].priority < p[pos].priority)
                        pos = j;
                }
                temppro = p[i];
                p[i] = p[pos];
                p[pos] = temppro;
            }
            totalwaitingtime = 0, totalturnaround = 0;
            p[0].waiting = 0;
            p[0].turnaround = p[0].burst;
            totalturnaround += p[0].turnaround;
            for (int i = 1; i < no_of_process; i++)
            {
                if (p[i - 1].waiting + p[i - 1].burst - p[i].arrival > 0)
                {
                    p[i].waiting = p[i - 1].waiting + p[i - 1].burst - p[i].arrival;
                }
                else
                {
                    p[i].waiting = 0;
                }
                totalwaitingtime += p[i].waiting;
                p[i].turnaround = p[i].burst + p[i].waiting;
                totalturnaround += p[i].turnaround;
            }
            printf("\nP_ID\tBurst Time\tPriority\tWaiting Time\t\tTurnaround Time\n");
            for (int i = 0; i < no_of_process; i++)
            {
                printf("%s\t\t%d\t\t%d\t\t%d\t\t\t%d\n", p[i].pid, p[i].burst,
p[i].priority, p[i].waiting, p[i].turnaround);
            }

            float avgwaiting = (float)(totalwaitingtime / no_of_process);
            float avgturnaround = (float)(totalturnaround / no_of_process);
            printf("\n\t\tAVERAGE \tWaitingTime =%.2f\t TurnaroundTime =%.2f\n",
totalwaitingtime / no_of_process, totalturnaround / no_of_process);
            print_gantt_chart(p, no_of_process);
            break;
        }
```

```
        case 2:
        {
            printf("\nPriority-Preemptive\n");
            int no_of_process;
            printf("\nNumber of process :");
            scanf(" %d", &no_of_process);
            int tempburst[100];
            for (int i = 0; i < no_of_process; i++)
            {
                printf("\n\nProcess %d\n", i + 1);
                printf("Process ID: ");
                scanf(" %s", p[i].pid);
                printf("Arrival Time :");
                scanf(" %d", &p[i].arrival);
                printf("Burst Time :");
                scanf(" %d", &p[i].burst);
                printf("Priority :");
                scanf(" %d", &p[i].priority);
                tempburst[i] = p[i].burst;
                p[i].teempburst = p[i].burst;
            }

            int rem_time[no_of_process];
            for (int i = 0; i < no_of_process; i++)
                rem_time[i] = p[i].burst;

            process tempro[100];
            int tempcount = 0;
            int completed = 0;
            int cur_time = 0;
            while (completed < no_of_process)
            {
                int idx = -1;
                for (int i = 0; i < no_of_process; i++)
                {
                    if (p[i].arrival <= cur_time && rem_time[i] > 0 && (idx == -1 ||
p[i].priority < p[idx].priority))
                        idx = i;
                }
                cur_time++;
                if (tempcount != 0 && strcmp(tempro[tempcount-1].pid,p[idx].pid))
tempcount--;
                else
                {
                    tempro[tempcount] = p[idx];
                }
                strcpy(tempro[tempcount].pid,p[idx].pid);
                tempro[tempcount].burst++;
                tempro[tempcount].turnaround = cur_time;
                tempcount++;
                rem_time[idx]--;
                if(rem_time[idx]==0)
                {
                    completed++;
```

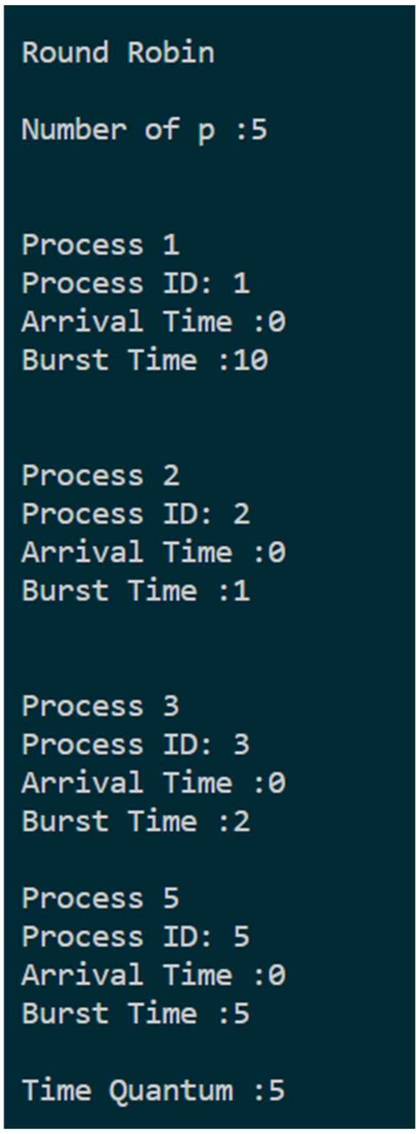
```c
                    p[idx].completion = cur_time;
                    p[idx].waiting = p[idx].completion - p[idx].arrival - p[idx].burst;
                    p[idx].turnaround = p[idx].burst + p[idx].waiting;
                }
            }

            for (int i = 0; i < no_of_process; i++)
            {
                totalwaitingtime+=p[i].waiting;
                totalturnaround+=p[i].turnaround;
            }
            printf("\nP_ID\tArrival Time\tBurst Time\tPriority\tWaiting Time\t\tTurnaround
Time\n");
            for (int i = 0; i < no_of_process; i++)
            {
                printf("%s\t\t%d\t\t%d\t\t%d\t\t%d\t\t\t%d\n", p[i].pid, p[i].arrival,
p[i].burst, p[i].priority, p[i].waiting, p[i].turnaround);
            }
            float avgwaiting = (float)(totalwaitingtime / no_of_process);
            float avgturnaround = (float)(totalturnaround / no_of_process);
            printf("\n\t\tAVERAGE \tWaitingTime =%.2f\t TurnaroundTime =%.2f\n",
avgwaiting, avgturnaround);
            process temmptemppro[100];
            int temptempcount=-1;
            for(int i=0;i<tempcount;i++)
            {
                if(strcmp(tempro[i+1].pid,tempro[i].pid)!=0)
                {
                    temmptemppro[++temptempcount]=tempro[i];
                }
            }


            print_gantt_chart(temmptemppro, temptempcount+1);
            print_gantt_chart(tempro, tempcount);
            break;
        }
        case 3:
        {
            printf("\nRound Robin\n");
            int no_of_process;
            int quantum;
            printf("\nNumber of p :");
            scanf(" %d", &no_of_process);
            int temp_nop = no_of_process;
            process temppro[100];
            int tempburst[100];
            int count = 0;
            int tempcount = -1;
            for (int i = 0; i < no_of_process; i++)
            {
                printf("\n\nProcess %d\n", i + 1);
                printf("Process ID: ");
                scanf(" %s", p[i].pid);
                printf("Arrival Time :");
                scanf(" %d", &p[i].arrival);
                printf("Burst Time :");
                scanf(" %d", &p[i].burst);
                tempburst[i] = p[i].burst;
            }

            process tempppro;
            for (int i = 0; i < no_of_process; i++)
            {
                pos = i;
                for (int j = i + 1; j < no_of_process; j++)
                {
                    if (p[j].arrival < p[pos].arrival)
                        pos = j;
                }
                tempppro = p[i];
                p[i] = p[pos];
                p[pos] = tempppro;
            }

            totalwaitingtime = 0, totalturnaround = 0;
            p[0].waiting = 0;
            printf("\nTime Quantum :");
            scanf(" %d", &quantum);
            for (int sum = 0, i = 0; temp_nop != 0;)
            {
                if (tempburst[i] <= quantum && tempburst[i] > 0)
                {
                    int temptempburst = tempburst[i];
                    sum = sum + tempburst[i];
                    tempburst[i] = 0;
                    count = 1;

                    tempcount++;
                    strcpy(temppro[tempcount].pid, p[i].pid);
                    temppro[tempcount].burst = temptempburst;
                    temppro[tempcount].arrival = p[i].arrival;
                    temppro[tempcount].turnaround = sum;
                }
                else if (tempburst[i] > 0)
                {

                    tempburst[i] = tempburst[i] - quantum;
                    sum = sum + quantum;

                    tempcount++;
                    strcpy(temppro[tempcount].pid, p[i].pid);
                    temppro[tempcount].burst = quantum;
                    temppro[tempcount].arrival = p[i].arrival;
                    temppro[tempcount].turnaround = sum;
                    temppro[tempcount].waiting = sum - p[i].arrival - quantum;
                }
                if (tempburst[i] == 0 && count == 1)
```

```
                {
                    temp_nop--;


                    p[i].turnaround = sum - p[i].arrival;
                    p[i].waiting = sum - p[i].arrival - p[i].burst;
                    totalwaitingtime = totalwaitingtime + sum - p[i].arrival - p[i].burst;
                    totalturnaround = totalturnaround + sum - p[i].arrival;
                    count = 0;
                }

                if (p[i + 1].arrival <= sum)
                {
                    i++;
                }
                else
                {
                    i = 0;
                }
            }
            printf("\nP_ID\tArrival Time\tBurst Time\tWaiting Time\t\tTurnaround Time\n");
            for (int i = 0; i < no_of_process; i++)
            {
                printf("%s\t\t%d\t\t%d\t\t%d\t\t\t%d\n", p[i].pid, p[i].arrival,
p[i].burst, p[i].waiting, p[i].turnaround);
            }
            float avgwaiting = (float)(totalwaitingtime / no_of_process);
            float avgturnaround = (float)(totalturnaround / no_of_process);
            printf("\n\t\tAVERAGE \tWaitingTime =%.2f\t TurnaroundTime =%.2f\n",
avgwaiting, avgturnaround);
            print_gantt_chart(temppro, tempcount + 1);
            break;
        }
        case 4:
            printf("Exiting...");
            return 0;
        }
        printf("\nWant to Continue (Y/N):");
        scanf(" %c", &ch);
    }
    return 0;
}
```

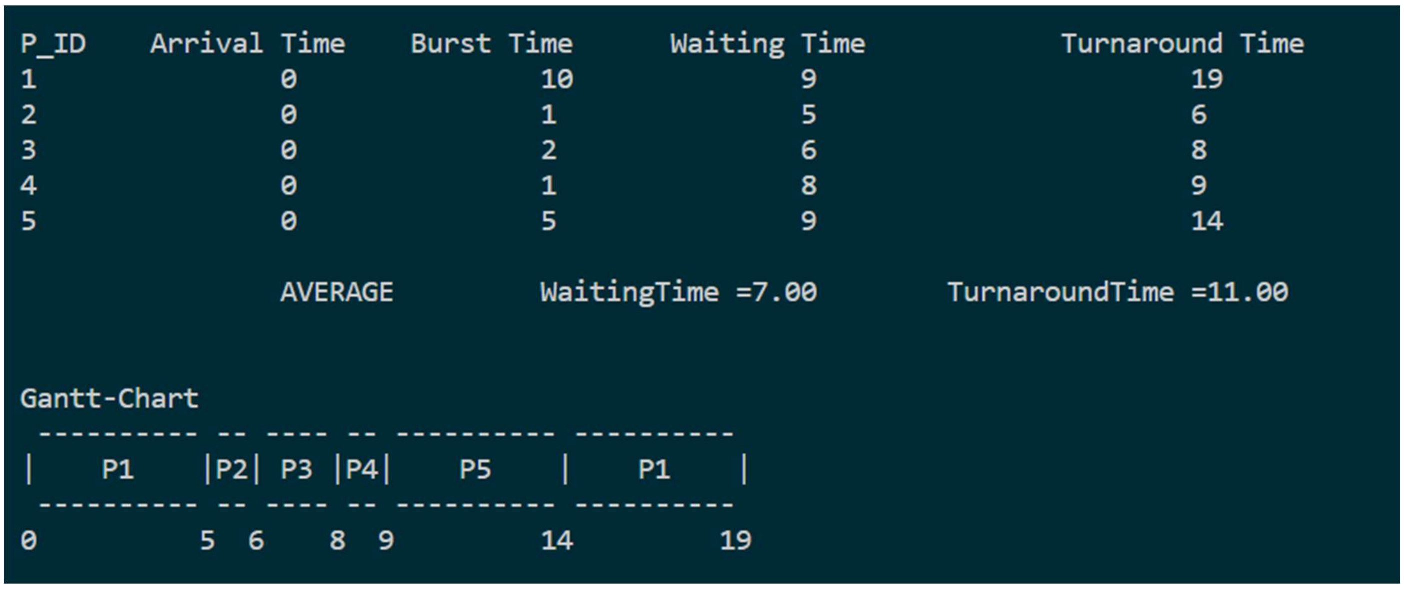
Output:



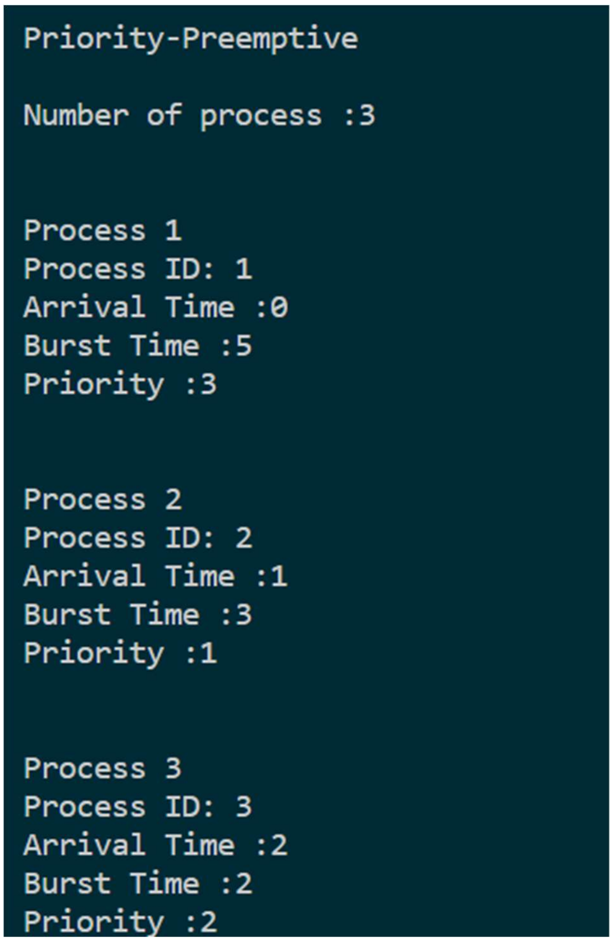
```
Menu
        1.Priority-Non Preemptive
        2.Priority-Preemptive
        3.Round Robin
        4.Exit

Enter Choice:3
```



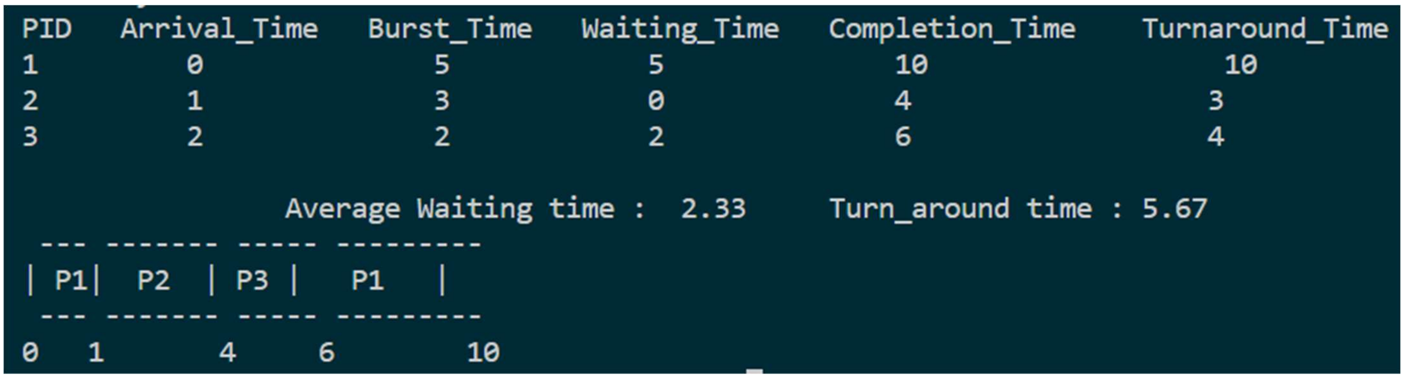
```
Round Robin

Number of p :5


Process 1
Process ID: 1
Arrival Time :0
Burst Time :10


Process 2
Process ID: 2
Arrival Time :0
Burst Time :1


Process 3
Process ID: 3
Arrival Time :0
Burst Time :2

Process 5
Process ID: 5
Arrival Time :0
Burst Time :5

Time Quantum :5
```



```
P_ID    Arrival Time    Burst Time      Waiting Time            Turnaround Time
1               0               10              9                       19
2               0               1               5                       6
3               0               2               6                       8
4               0               1               8                       9
5               0               5               9                       14

                AVERAGE         WaitingTime =7.00       TurnaroundTime =11.00


Gantt-Chart
 ---------- -- ---- -- ---------- ----------
|    P1    |P2| P3 |P4|    P5    |    P1    |
 ---------- -- ---- -- ---------- ----------
0          5  6    8  9         14         19
```



```
Priority-Preemptive

Number of process :3


Process 1
Process ID: 1
Arrival Time :0
Burst Time :5
Priority :3


Process 2
Process ID: 2
Arrival Time :1
Burst Time :3
Priority :1


Process 3
Process ID: 3
Arrival Time :2
Burst Time :2
Priority :2
```



```
PID    Arrival_Time    Burst_Time    Waiting_Time    Completion_Time    Turnaround_Time
1           0               5             5               10                  10
2           1               3             0               4                  3
3           2               2             2               6                  4

                Average Waiting time :  2.33     Turn_around time : 5.67
 --- ------- ----- ---------
| P1|   P2  | P3 |    P1   |
 --- ------- ----- ---------
0   1       4     6         10
```

Learning Outcome:

- Implemented Pre-emptive Priority Scheduling and Round Robin Scheduling in C program
- Displayed Gantt Chart for the above scheduling methods