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

**→FCFS**

**→ SJF (pre-emptive & Non-preemptive)**

**Program:**

**a.FCFS**

```
#include <stdio.h>

#define MAX_PROCESS 10

void fcfs(int n, int at[], int bt[]) {
   int ct[MAX_PROCESS];
   int tat[MAX_PROCESS];
   int wt[MAX_PROCESS];

   int total_wt = 0;
   int total_tat = 0;

   int current_time = 0;

   // Initialize completion time array with -1
   for (int i = 0; i < n; i++) {
      ct[i] = -1;
   }

   // Find completion time for each process
   for (int i = 0; i < n; i++) {
      if (current_time < at[i]) {
         current_time = at[i];
      }
```

```
        ct[i] = current_time + bt[i];
        current_time = ct[i];
    }

    // Find turnaround time for each process
    for (int i = 0; i < n; i++) {
        tat[i] = ct[i] - at[i];
        total_tat += tat[i];
    }

    // Find waiting time for each process
    for (int i = 0; i < n; i++) {
        wt[i] = tat[i] - bt[i];
        total_wt += wt[i];
    }

    // Print the results
    printf("\nProcess\tArrival Time\tBurst Time\tCompletion Time\tTurnaround Time\tWaiting Time\n");
    for (int i = 0; i < n; i++) {
        printf("P%d\t%d\t\t%d\t\t%d\t\t%d\t\t%d\n", i+1, at[i], bt[i], ct[i], tat[i], wt[i]);
    }

    printf("\nAverage waiting time: %.2f", (float)total_wt / n);
    printf("\nAverage turnaround time: %.2f", (float)total_tat / n);
}

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

```
    int at[n], bt[n];

    printf("Enter the arrival time:\n");
    for (i = 0; i < n; i++) {
        scanf("%d", &at[i]);
    }

    printf("Enter the burst time:\n");
    for (i = 0; i < n; i++) {
        scanf("%d", &bt[i]);
    }

    fcfs(n, at, bt);

    return 0;
}
```

**Output:**

```
Enter the number of processes: 4
Enter the arrival time:
0
1
5
6
Enter the burst time:
2
2
3
4

Process Arrival Time    Burst Time      Completion Time Turnaround Time Waiting Time
P1      0               2               2               2               0
P2      1               2               4               3               1
P3      5               3               8               3               0
P4      6               4               12              6               2

Average waiting time: 0.75
Average turnaround time: 3.50
Process returned 0 (0x0)   execution time : 16.964 s
Press any key to continue.
```

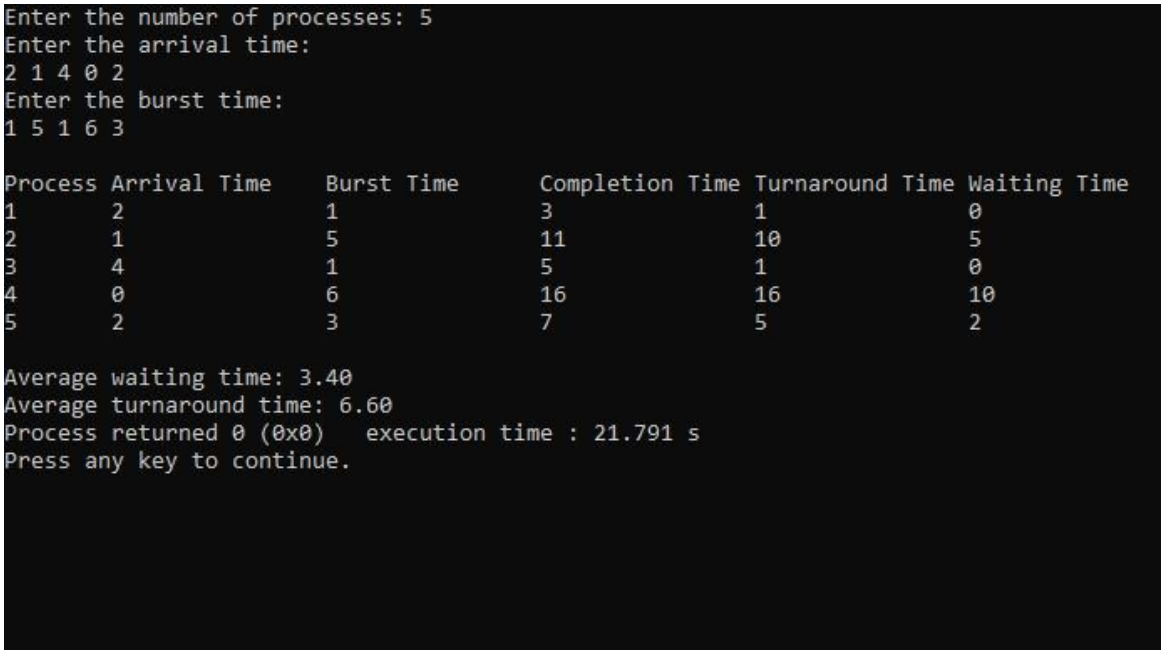
**b. SJF (pre-emptive)**

```
#include <stdio.h>
#define MAX 10
void sjf_preemptive(int n, int at[], int bt[]) {
   int ct[MAX];
   int tat[MAX];
   int wt[MAX];
   int rt[MAX];
   int total_wt = 0;
   int total_tat = 0;
   int completed = 0;
   int current_time = 0;
   int is_completed[MAX] = {0};
   for (int i = 0; i < n; i++) {
      rt[i] = bt[i];
   }
  while (completed < n) {
      int shortest_job = -1;
      int min_bt = 9999;
 for (int i = 0; i < n; i++) {
         if (at[i] <= current_time && rt[i] < min_bt && rt[i] > 0) {
            shortest_job = i;
            min_bt = rt[i];
         }
      }
 if (shortest_job == -1) {
         current_time++;
         continue;
      }
 rt[shortest_job]--;
 if (rt[shortest_job] == 0) {
```

```
            completed++;
ct[shortest_job] = current_time + 1;
 tat[shortest_job] = ct[shortest_job] - at[shortest_job];
            total_tat += tat[shortest_job];


            wt[shortest_job] = tat[shortest_job] - bt[shortest_job];
            if (wt[shortest_job] < 0) wt[shortest_job] = 0;
            total_wt += wt[shortest_job];
     is_completed[shortest_job] = 1;
        }
    current_time++;
    }
  printf("\nProcess\tArrival Time\tBurst Time\tCompletion Time\tTurnaround Time\tWaiting
Time\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", i + 1, at[i], bt[i], ct[i], tat[i], wt[i]);
    }
    printf("\nAverage waiting time: %.2f", (float)total_wt / n);
    printf("\nAverage turnaround time: %.2f", (float)total_tat / n);
}
int main() {
    int n, i;
    printf("Enter the number of processes: ");
    scanf("%d", &n);
    int at[n], bt[n];
   printf("Enter the arrival time:\n");
    for (i = 0; i < n; i++) {
        scanf("%d", &at[i]);
    }
    printf("Enter the burst time:\n");
    for (i = 0; i < n; i++) {
        scanf("%d", &bt[i]);
```

```
    }
    sjf_preemptive(n, at, bt);
     return 0;
}
```

**Output:**



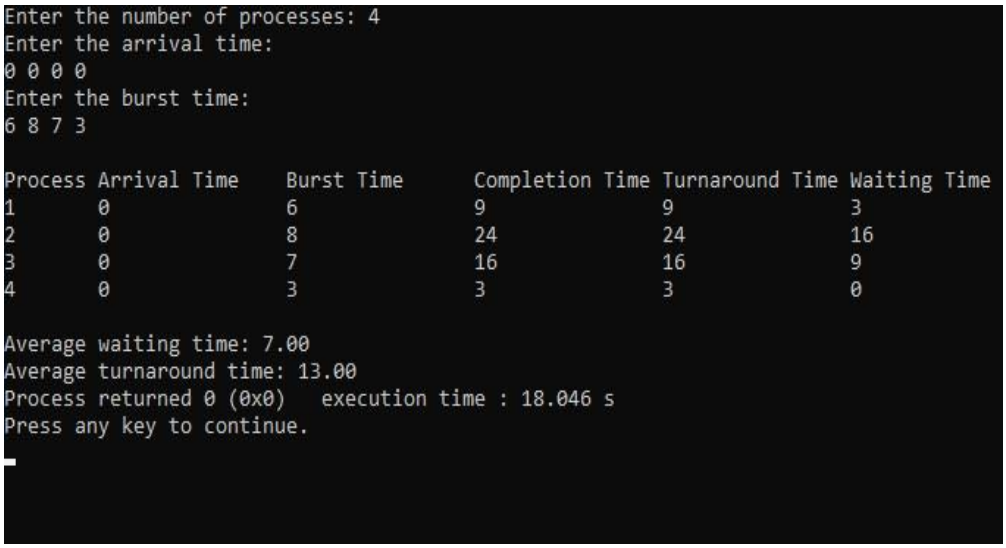

**c.SJF (Non-preemptive)**

```
#include <stdio.h>
#define MAX 10
void sjf_non_preemptive(int n, int at[], int bt[]) {
    int ct[MAX];
    int tat[MAX];
    int wt[MAX];
    int rt[MAX];
    int total_wt = 0;
    int total_tat = 0;
    int completed = 0;
    int current_time = 0;
    int shortest_job = 0;
    int min_bt = 9999;
    int is_completed[MAX] = {0};
```

```
    for (int i = 0; i < n; i++) {
        rt[i] = bt[i];
    }
    while (completed < n) {
        for (int i = 0; i < n; i++) {
            if (at[i] <= current_time && rt[i] < min_bt && !is_completed[i]) {
                shortest_job = i;
                min_bt = rt[i];
            }
        }
        rt[shortest_job]--;
        if (rt[shortest_job] == 0) {
            completed++;
            min_bt = 9999;
            is_completed[shortest_job] = 1;
            ct[shortest_job] = current_time + 1;
            tat[shortest_job] = ct[shortest_job] - at[shortest_job];
            total_tat += tat[shortest_job];
            wt[shortest_job] = tat[shortest_job] - bt[shortest_job];
            if (wt[shortest_job] < 0) wt[shortest_job] = 0;
            total_wt += wt[shortest_job];
        }
        current_time++;
    }
    printf("\nProcess\tArrival Time\tBurst Time\tCompletion Time\tTurnaround Time\tWaiting
Time\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", i + 1, at[i], bt[i], ct[i], tat[i], wt[i]);
    }

    printf("\nAverage waiting time: %.2f", (float)total_wt / n);
    printf("\nAverage turnaround time: %.2f", (float)total_tat / n);
```

```
}

int main() {
   int n, i;
   printf("Enter the number of processes: ");
   scanf("%d", &n);
   int at[n], bt[n];
   printf("Enter the arrival time:\n");
   for (i = 0; i < n; i++) {
      scanf("%d", &at[i]);
   }
   printf("Enter the burst time:\n");
   for (i = 0; i < n; i++) {
      scanf("%d", &bt[i]);
   }
sjf_non_preemptive(n, at, bt);
   return 0;
}
```

**Output:**



**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)**

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

**Program:**

**a.Priority (pre-emptive)**

```
#include<stdio.h>
void sort (int proc_id[], int p[], int at[], int bt[], int b[], int n){
  int min = p[0], temp = 0;
  for (int i = 0; i < n; i++){
            min = p[i];
            for (int j = i; j < n; j++){
                        if (p[j] < min){
                                    temp = at[i];
                                    at[i] = at[j];
                                    at[j] = temp;
                                    temp = bt[j];
                                    bt[j] = bt[i];
                                    bt[i] = temp;
                                    temp = b[j];
                                    b[j] = b[i];
                                    b[i] = temp;
                                    temp = p[j];
                                    p[j] = p[i];
                                    p[i] = temp;
                                    temp = proc_id[i];
                                    proc_id[i] = proc_id[j];
                                    proc_id[j] = temp;
                                   }
                       }
           }
```

```
}
void main (){
  int n, c = 0;
  printf ("Enter number of processes: ");
  scanf ("%d", &n);
  int proc_id[n], at[n], bt[n], ct[n], tat[n], wt[n], m[n], b[n], rt[n], p[n];
  double avg_tat = 0.0, ttat = 0.0, avg_wt = 0.0, twt = 0.0;
  for (int i = 0; i < n; i++){
              proc_id[i] = i + 1;
              m[i] = 0;
             }
  printf ("Enter priorities:\n");
  for (int i = 0; i < n; i++)
             scanf ("%d", &p[i]);
  printf ("Enter arrival times:\n");
  for (int i = 0; i < n; i++)
             scanf ("%d", &at[i]);
  printf ("Enter burst times:\n");
  for (int i = 0; i < n; i++){
              scanf ("%d", &bt[i]);
              b[i] = bt[i];
              m[i] = -1;
              rt[i] = -1;
             }
sort(proc_id, p, at, bt, b, n);
  int count = 0, pro = 0, priority = p[0];
  int x = 0;
  c = 0;
  while (count < n){
              for (int i = 0; i < n; i++){
                          if (at[i] <= c && p[i] >= priority && b[i] > 0 && m[i] != 1){
```

```
                        x = i;
                        priority = p[i];
                    }
                }
            if (b[x] > 0){
                    if (rt[x] == -1)
                        rt[x] = c - at[x];
                    b[x]--;
                    c++;
                }
            if (b[x] == 0){
                    count++;
                    ct[x] = c;
                    m[x] = 1;
                    while (x >= 1 && b[x] == 0)
                        priority = p[--x];
                }
            if (count == n)
                    break;
            }
    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];
    printf ("Priority scheduling(Pre-Emptive):\n");
    printf ("PID\tPrior\tAT\tBT\tCT\tTAT\tWT\tRT\n");
    for (int i = 0; i < n; i++)
            printf ("P%d\t %d\t\t%d\t%d\t%d\t%d\t%d\t%d\n", proc_id[i], p[i], at[i],
                        bt[i], ct[i], tat[i], wt[i], rt[i]);
    for (int i = 0; i < n; i++){
            ttat += tat[i];
```

```
            twt += wt[i];
          }
  avg_tat = ttat / (double) n;
  avg_wt = twt / (double) n;
  printf ("\nAverage turnaround time:%lfms\n", avg_tat);
  printf ("\nAverage waiting time:%lfms\n", avg_wt);
}
```

**Output:**

```
Enter number of processes: 4
Enter priorities:
10 20 30 40
Enter arrival times:
0 1 2 4
Enter burst times:
5 4 2 1
Priority scheduling(Pre-Emptive):
PID     Prior   AT      BT      CT      TAT     WT      RT
P1       10             0       5       12      12      7       0
P2       20             1       4       8       7       3       0
P3       30             2       2       4       2       0       0
P4       40             4       1       5       1       0       0

Average turnaround time:5.500000ms

Average waiting time:2.500000ms

Process returned 33 (0x21)   execution time : 22.246 s
Press any key to continue.
```

**b. Priority (Non-pre-emptive)**

```
#include<stdio.h>
void sort (int proc_id[], int p[], int at[], int bt[], int n){
  int min = p[0], temp = 0;
  for (int i = 0; i < n; i++)
          {
            min = p[i];
            for (int j = i; j < n; j++)
                    {
                      if (p[j] < min)
```

```
                {
                  temp = at[i];
                  at[i] = at[j];
                  at[j] = temp;
                  temp = bt[j];
                  bt[j] = bt[i];
                  bt[i] = temp;
                  temp = p[j];
                  p[j] = p[i];
                  p[i] = temp;
                  temp = proc_id[i];
                  proc_id[i] = proc_id[j];
                  proc_id[j] = temp;
                }
            }
        }
}

void main (){
  int n, c = 0;
  printf ("Enter number of processes: ");
  scanf ("%d", &n);
  int proc_id[n], at[n], bt[n], ct[n], tat[n], wt[n], m[n], rt[n], p[n];
  double avg_tat = 0.0, ttat = 0.0, avg_wt = 0.0, twt = 0.0;
  for (int i = 0; i < n; i++){
        proc_id[i] = i + 1;
        m[i] = 0;
  }
  printf ("Enter priorities:\n");
  for (int i = 0; i < n; i++)
        scanf ("%d", &p[i]);
```

```
 printf ("Enter arrival times:\n");
 for (int i = 0; i < n; i++)
          scanf ("%d", &at[i]);
 printf ("Enter burst times:\n");
 for (int i = 0; i < n; i++)
          {
            scanf ("%d", &bt[i]);
            m[i] = -1;
            rt[i] = -1;
          }
sort (proc_id, p, at, bt, n);
 int count = 0, pro = 0, priority = p[0];
 int x = 0;
 c = 0;
 while (count < n){
          for (int i = 0; i < n; i++){
                   if (at[i] <= c && p[i] >= priority && m[i] != 1){
                            x = i;
                            priority = p[i];
                   }
          }
          if (rt[x] == -1)
            rt[x] = c - at[x];
          if (at[x] <= c)
            c += bt[x];
          else
       c += at[x] - c + bt[x];
            count++;
            ct[x] = c;
            m[x] = 1;
            while (x >= 1 && m[--x] != 1)     {
```

```
                priority = p[x];
                break;
            }
            x++;
            if (count == n)
                break;
        }
    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];
    printf ("\nPriority scheduling:\n");
    printf ("PID\tPrior\tAT\tBT\tCT\tTAT\tWT\tRT\n");
    for (int i = 0; i < n; i++)
        printf ("P%d\t %d\t\t%d\t%d\t%d\t%d\t%d\t%d\n", proc_id[i], p[i], at[i],
                bt[i], ct[i], tat[i], wt[i], rt[i]);
    for (int i = 0; i < n; i++){
            ttat += tat[i];
            twt += wt[i];
        }
    avg_tat = ttat / (double) n;
    avg_wt = twt / (double) n;
    printf ("\nAverage turnaround time:%lfms\n", avg_tat);
    printf ("\nAverage waiting time:%lfms\n", avg_wt);
}
```

**Output:**

```
Enter number of processes: 4
Enter priorities:
10 20 30 40
Enter arrival times:
0 1 2 4
Enter burst times:
5 4 2 1

Priority scheduling:
PID     Prior   AT      BT      CT      TAT     WT      RT
P1       10             0       5       5       5       0       0
P2       20             1       4       12      11      7       7
P3       30             2       2       8       6       4       4
P4       40             4       1       6       2       1       1

Average turnaround time:6.000000ms

Average waiting time:3.000000ms

Process returned 33 (0x21)   execution time : 22.748 s
Press any key to continue.
```

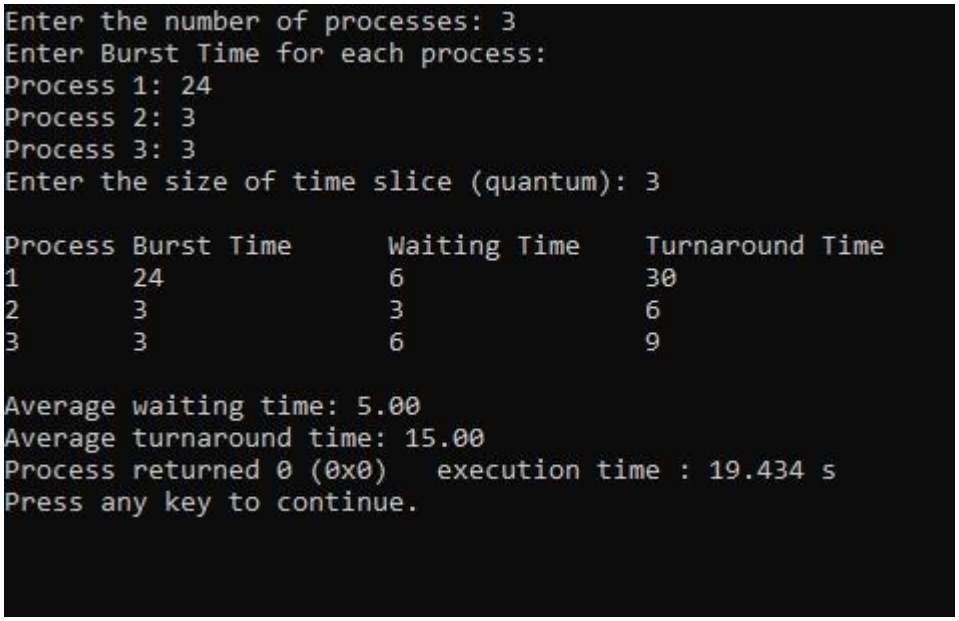
**c. Round Robin (Experiment with different quantum sizes for RR algorithm)**

```
include <stdio.h>

#define MAX 10

void round_robin(int n, int bt[], int quantum) {
   int wt[MAX] = {0};
   int tat[MAX] = {0};
   int remaining_bt[MAX];
   int total_wt = 0, total_tat = 0;
   int time = 0;
   for (int i = 0; i < n; i++) {
      remaining_bt[i] = bt[i];
   }
   while (1) {
      int done = 1;
      for (int i = 0; i < n; i++) {
         if (remaining_bt[i] > 0) {
            done = 0;
            if (remaining_bt[i] > quantum) {
               time += quantum;
```

```
                remaining_bt[i] -= quantum;
            } else {
                time += remaining_bt[i];
                wt[i] = time - bt[i];
                remaining_bt[i] = 0;
            }
        }
    }

    if (done == 1) break;
  }
  for (int i = 0; i < n; i++) {
    tat[i] = bt[i] + wt[i];
    total_wt += wt[i];
    total_tat += tat[i];
  }
  printf("\nProcess\tBurst Time\tWaiting Time\tTurnaround Time\n");
  for (int i = 0; i < n; i++) {
    printf("%d\t%d\t\t%d\t\t%d\n", i + 1, bt[i], wt[i], tat[i]);
  }
  printf("\nAverage waiting time: %.2f", (float)total_wt / n);
  printf("\nAverage turnaround time: %.2f", (float)total_tat / n);
}
int main() {
  int n, quantum;
  printf("Enter the number of processes: ");
  scanf("%d", &n);
  int bt[MAX];
  printf("Enter Burst Time for each process:\n");
  for (int i = 0; i < n; i++) {
    printf("Process %d: ", i + 1);
```

```
        scanf("%d", &bt[i]);
    }
    printf("Enter the size of time slice (quantum): ");
    scanf("%d", &quantum);
    round_robin(n, bt, quantum);
    return 0;
}
```

**Output:**




**3.Write a C program to simulate multi-level queue scheduling algorithm considering the following scenario. All the processes in the system are divided into two categories – system processes and user processes. System processes are to be given higher priority than user processes. Use FCFS scheduling for the processes in each queue.**

**Program:**

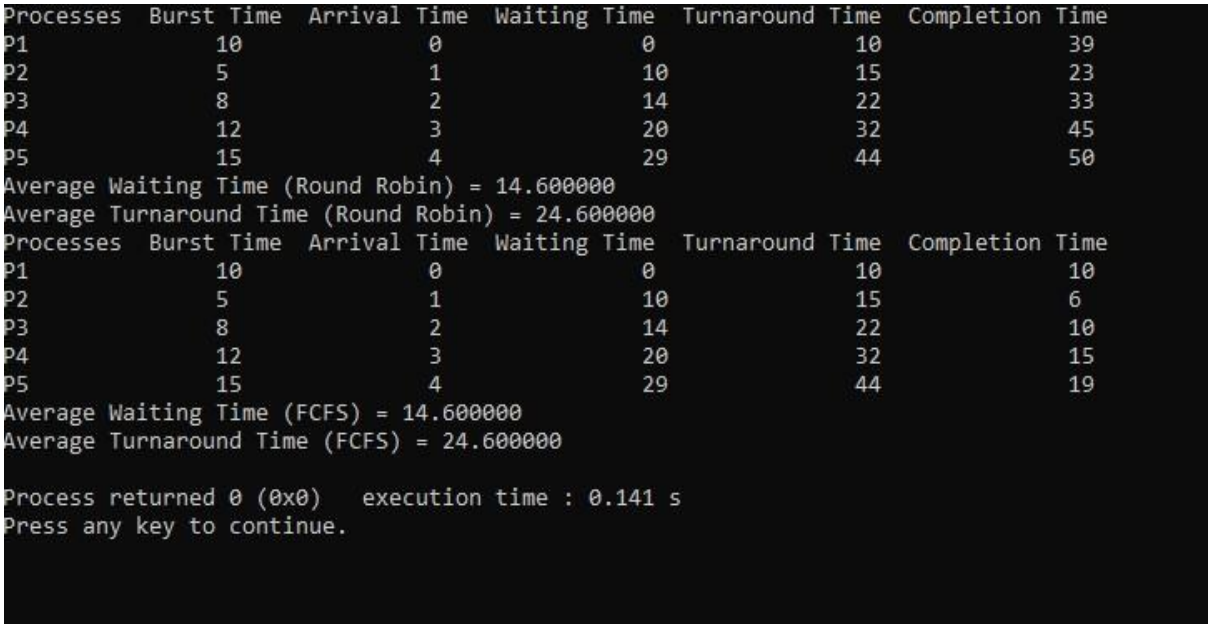
```
#include <stdio.h>
void findWaitingTime(int processes[], int n, int bt[], int at[], int wt[]) {
    wt[0] = 0;
    for (int i = 1; i < n; i++) {
        wt[i] = bt[i-1] + wt[i-1] - at[i-1];
        if (wt[i] < 0)
```

```
            wt[i] = 0;
        }
    }
    void findTurnaroundTime(int processes[], int n, int bt[], int wt[], int tat[]) {
        for (int i = 0; i < n; i++) {
            tat[i] = bt[i] + wt[i];
        }
    }
    void roundRobin(int processes[], int n, int bt[], int at[], int quantum) {
        int wt[n], tat[n], ct[n], total_wt = 0, total_tat = 0;
        int remaining_bt[n];
        int completed = 0;
        int time = 0;
        for (int i = 0; i < n; i++) {
            remaining_bt[i] = bt[i];
        }
        while (completed < n) {
            for (int i = 0; i < n; i++) {
                if (remaining_bt[i] > 0 && at[i] <= time) {
                    if (remaining_bt[i] <= quantum) {
                        time += remaining_bt[i];
                        remaining_bt[i] = 0;
                        ct[i] = time;
                        completed++;
                    } else {
                        time += quantum;
                        remaining_bt[i] -= quantum;
                    }
                }
            }
        }
```

```
    findWaitingTime(processes, n, bt, at, wt);
    findTurnaroundTime(processes, n, bt, wt, tat);
    printf("Processes  Burst Time  Arrival Time  Waiting Time  Turnaround Time  Completion Time\n");
    for (int i = 0; i < n; i++) {
        printf("P%d\t\t%d\t\t%d\t\t%d\t\t%d\t\t%d\n", processes[i], bt[i], at[i], wt[i], tat[i], ct[i]);
        total_wt += wt[i];
        total_tat += tat[i];
    }
    printf("Average Waiting Time (Round Robin) = %f\n", (float)total_wt / n);
    printf("Average Turnaround Time (Round Robin) = %f\n", (float)total_tat / n);
}
void fcfs(int processes[], int n, int bt[], int at[]) {
    int wt[n], tat[n], ct[n], total_wt = 0, total_tat = 0;
    findWaitingTime(processes, n, bt, at, wt);
    findTurnaroundTime(processes, n, bt, wt, tat);
    printf("Processes  Burst Time  Arrival Time  Waiting Time  Turnaround Time  Completion Time\n");
    for (int i = 0; i < n; i++) {
        ct[i] = at[i] + bt[i];
        printf("P%d\t\t%d\t\t%d\t\t%d\t\t%d\t\t%d\n", processes[i], bt[i], at[i], wt[i], tat[i], ct[i]);
        total_wt += wt[i];
        total_tat += tat[i];
    }
    printf("Average Waiting Time (FCFS) = %f\n", (float)total_wt / n);
    printf("Average Turnaround Time (FCFS) = %f\n", (float)total_tat / n);
}
int main() {
    int processes[] = {1, 2, 3, 4, 5};
    int n = sizeof(processes) / sizeof(processes[0]);
    int bt[] = {10, 5, 8, 12, 15};
    int at[] = {0, 1, 2, 3, 4};
    int quantum = 2;
```

```
    roundRobin(processes, n, bt, at, quantum);
    fcfs(processes, n, bt, at);
    return 0;
}
```

**Output:**



```
Processes  Burst Time  Arrival Time  Waiting Time  Turnaround Time  Completion Time
P1              10             0              0               10               39
P2              5              1              10              15               23
P3              8              2              14              22               33
P4              12             3              20              32               45
P5              15             4              29              44               50
Average Waiting Time (Round Robin) = 14.600000
Average Turnaround Time (Round Robin) = 24.600000
Processes  Burst Time  Arrival Time  Waiting Time  Turnaround Time  Completion Time
P1              10             0              0               10               10
P2              5              1              10              15               6
P3              8              2              14              22               10
P4              12             3              20              32               15
P5              15             4              29              44               19
Average Waiting Time (FCFS) = 14.600000
Average Turnaround Time (FCFS) = 24.600000

Process returned 0 (0x0)   execution time : 0.141 s
Press any key to continue.
```

**4. Write a C program to simulate Real-Time CPU Scheduling algorithms:**

**a) Rate- Monotonic**

**b) Earliest-deadline First**

**c) Proportional scheduling**

**Program**

**a) Rate- Monotonic**

```
#include <stdio.h>
#include <stdlib.h>
#include <math.h>
voidsort (int proc[], int b[], int pt[], int n){
  int temp = 0;
  for (int i = 0; i < n; i++){
            for (int j = i; j < n; j++){
                      if (pt[j] < pt[i]){
                                temp = pt[i];
```

```
                    pt[i] = pt[j];
                    pt[j] = temp;
                    temp = b[j];
                    b[j] = b[i];
                    b[i] = temp;
                    temp = proc[i];
                    proc[i] = proc[j];
                    proc[j] = temp;
                   }
                }
            }
}
int gcd (int a, int b){
  int r;
  while (b > 0){
             r = a % b;
             a = b;
             b = r;
            }
  return a;
}
int lcmul (int p[], int n){
  int lcm = p[0];
  for (int i = 1; i < n; i++){
             lcm = (lcm * p[i]) / gcd (lcm, p[i]);
            }
  return lcm;
}
void main (){
  int n;
  printf ("Enter the number of processes:");
```

```
scanf ("%d", &n);
int proc[n], b[n], pt[n], rem[n];
printf ("Enter the CPU burst times:\n");
for (int i = 0; i < n; i++){
            scanf ("%d", &b[i]);
            rem[i] = b[i];
          }
printf ("Enter the time periods:\n");
for (int i = 0; i < n; i++)
          scanf ("%d", &pt[i]);
for (int i = 0; i < n; i++)
          proc[i] = i + 1;
sort (proc, b, pt, n);
int l = lcmul (pt, n);
printf ("LCM=%d\n", l);
printf ("\nRate Monotone Scheduling:\n");
printf ("PID\t Burst\tPeriod\n");
for (int i = 0; i < n; i++)
          printf ("%d\t\t%d\t\t%d\n", proc[i], b[i], pt[i]);
double sum = 0.0;
for (int i = 0; i < n; i++){
            sum += (double) b[i] / pt[i];
          }
double rhs = n * (pow (2.0, (1.0 / n)) - 1.0);
printf ("\n%lf <= %lf =>%s\n", sum, rhs, (sum <= rhs) ? "true" : "false");
if (sum > rhs)
          exit (0);
printf ("Scheduling occurs for %d ms\n\n", l);
int time = 0, prev = 0, x = 0;
while (time < l){
            int f = 0;
```

```
        for (int i = 0; i < n; i++){
                if (time % pt[i] == 0)
                        rem[i] = b[i];
                if (rem[i] > 0){
                        if (prev != proc[i]){
                                printf ("%dms onwards: Process %d running\n", time,
                                                        proc[i]);
                                prev = proc[i];
                               }
                        rem[i]--;
                        f = 1;
                        break;
                        x = 0;
                       }
                }
        if (!f){
                if (x != 1){
                        printf ("%dms onwards: CPU is idle\n", time);
                        x = 1;
                       }
                }
        time++;
       }
}
```

**Output:**

```
Enter the number of processes:3
Enter the CPU burst times:
3 2 2
Enter the time periods:
20 5 10
LCM=20

Rate Monotone Scheduling:
PID      Burst  Period
2               2               5
3               2               10
1               3               20

0.750000 <= 0.779763 =>true
Scheduling occurs for 20 ms

0ms onwards: Process 2 running
2ms onwards: Process 3 running
4ms onwards: Process 1 running
5ms onwards: Process 2 running
7ms onwards: Process 1 running
8ms onwards: CPU is idle
10ms onwards: Process 2 running

Process returned 20 (0x14)   execution time : 22.670 s
Press any key to continue.
```

**b) Earliest-deadline First**

```
#include <stdio.h>

#include <stdlib.h>

#include <math.h>

void sort (int proc[], int d[], int b[], int pt[], int n){

  int temp = 0;

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

            for (int j = i; j < n; j++){

                      if (d[j] < d[i]){

                                temp = d[j];

                                d[j] = d[i];

                                d[i] = temp;

                                temp = pt[i];

                                pt[i] = pt[j];

                                pt[j] = temp;
```

```
                    temp = b[j];
                    b[j] = b[i];
                    b[i] = temp;
                    temp = proc[i];
                    proc[i] = proc[j];
                    proc[j] = temp;
                   }
                }
            }
}
int gcd (int a, int b){
  int r;
  while (b > 0){
              r = a % b;
              a = b;
              b = r;
            }
  return a;
}
int lcmul (int p[], int n){
  int lcm = p[0];
  for (int i = 1; i < n; i++){
              lcm = (lcm * p[i]) / gcd (lcm, p[i]);
            }
  return lcm;
}
void main (){
  int n;
  printf ("Enter the number of processes:");
  scanf ("%d", &n);
  int proc[n], b[n], pt[n], d[n], rem[n];
```

```
printf ("Enter the CPU burst times:\n");
for (int i = 0; i < n; i++){
            scanf ("%d", &b[i]);
            rem[i] = b[i];
          }
printf ("Enter the deadlines:\n");
for (int i = 0; i < n; i++)
          scanf ("%d", &d[i]);
printf ("Enter the time periods:\n");
for (int i = 0; i < n; i++)
          scanf ("%d", &pt[i]);
for (int i = 0; i < n; i++)
          proc[i] = i + 1;
sort (proc, d, b, pt, n);
int l = lcmul (pt, n);
printf ("\nEarliest Deadline Scheduling:\n");
printf ("PID\t Burst\tDeadline\tPeriod\n");
for (int i = 0; i < n; i++)
          printf ("%d\t\t%d\t\t%d\t\t%d\n", proc[i], b[i], d[i], pt[i]);
printf ("Scheduling occurs for %d ms\n\n", l);
int time = 0, prev = 0, x = 0;
int nextDeadlines[n];
for (int i = 0; i < n; i++){
            nextDeadlines[i] = d[i];
            rem[i] = b[i];
          }
while (time < l){
            for (int i = 0; i < n; i++){
                        if (time % pt[i] == 0 && time != 0){
                                    nextDeadlines[i] = time + d[i];
                                    rem[i] = b[i];
```

```
                    }
                }
            int minDeadline = l + 1;
            int taskToExecute = -1;
            for (int i = 0; i < n; i++){
                if (rem[i] > 0 && nextDeadlines[i] < minDeadline){
                    minDeadline = nextDeadlines[i];
                    taskToExecute = i;
                    }
                }
            if (taskToExecute != -1){
                printf ("%dms : Task %d is running.\n", time, proc[taskToExecute]);
                rem[taskToExecute]--;
                }
            else{
                printf ("%dms: CPU is idle.\n", time);
                }
            time++;
           }
}
```

**Output:**

```
Enter the CPU burst times:
0 1 2
Enter the deadlines:
8 5 4
Enter the time periods:
3 4 6

Earliest Deadline Scheduling:
PID      Burst  Deadline        Period
3               2               4               6
2               1               5               4
1               0               8               3
Scheduling occurs for 12 ms

0ms : Task 3 is running.
1ms : Task 3 is running.
2ms : Task 2 is running.
3ms: CPU is idle.
4ms : Task 2 is running.
5ms: CPU is idle.
6ms : Task 3 is running.
7ms : Task 3 is running.
8ms: CPU is idle.
9ms: CPU is idle.
10ms: CPU is idle.
11ms: CPU is idle.

Process returned 12 (0xC)   execution time : 18.265 s
Press any key to continue.
```

**c) Proportional scheduling**

```
#include <stdio.h>

#include <stdlib.h>

#include <time.h>

#define MAX_TASKS 10

#define MAX_TICKETS 100

#define TIME_UNIT_DURATION_MS 100

struct Task {
    int tid;
    int tickets;
};

void schedule(struct Task tasks[], int num_tasks, int *time_span_ms) {
    int total_tickets = 0;
    for (int i = 0; i < num_tasks; i++) {
        total_tickets += tasks[i].tickets;
```

```
    }
    srand(time(NULL));
    int current_time = 0;
    int completed_tasks = 0;
    printf("Process Scheduling:\n");
    while (completed_tasks < num_tasks) {
        int winning_ticket = rand() % total_tickets;
        int cumulative_tickets = 0;
        for (int i = 0; i < num_tasks; i++) {
            cumulative_tickets += tasks[i].tickets;
            if (winning_ticket < cumulative_tickets) {
                printf("Time %d-%d: Task %d is running\n", current_time, current_time + 1, tasks[i].tid);
                current_time++;
                break;
            }
        }
        completed_tasks++;
    }
    *time_span_ms = current_time * TIME_UNIT_DURATION_MS;
}
int main() {
    struct Task tasks[MAX_TASKS];
    int num_tasks;
    int time_span_ms;
    printf("Enter the number of tasks: ");
    scanf("%d", &num_tasks);
    if (num_tasks <= 0 || num_tasks > MAX_TASKS) {
        printf("Invalid number of tasks. Please enter a number between 1 and %d.\n", MAX_TASKS);
        return 1;
    }
    printf("Enter number of tickets for each task:\n");
```

```
    for (int i = 0; i < num_tasks; i++) {
        tasks[i].tid = i + 1;
        printf("Task %d tickets: ", tasks[i].tid);
        scanf("%d", &tasks[i].tickets);
    }
    printf("\nRunning tasks:\n");
    schedule(tasks, num_tasks, &time_span_ms);
    printf("\nTime span of the Gantt chart: %d milliseconds\n", time_span_ms);
    return 0;
}
```

**Output:**

```
Enter the number of tasks: 3
Enter number of tickets for each task:
Task 1 tickets: 10
Task 2 tickets: 20
Task 3 tickets: 30

Running tasks:
Process Scheduling:
Time 0-1: Task 3 is running
Time 1-2: Task 2 is running
Time 2-3: Task 1 is running

Time span of the Gantt chart: 300 milliseconds

Process returned 0 (0x0)   execution time : 18.093 s
Press any key to continue.
```

**5. Write a C program to simulate producer-consumer problem using semaphores.**

```
#include<stdio.h>
#include<stdlib.h>
int mutex = 1, full = 0, empty = 5, x = 0;
int main(){
int n;
void producer();
void consumer();
int wait(int);
```

```
int signal(int);
printf("\n1.Producer\n2.Consumer\n3.Exit");
while (1){
    printf("\nEnter your choice:");
    scanf("%d", &n);
    switch (n){
        case 1:
            if ((mutex == 1) && (empty != 0))
            producer();
            else
            printf("Buffer is full!!");
            break;
        case 2:
            if ((mutex == 1) && (full != 0))
                consumer();
            else
                printf("Buffer is empty!!");
                break;
        case 3:
            printf("Program execution completed.\n");
            exit(0);
            break;
      }
}
return 0;
}
int wait(int s){
      return (--s);
}
int signal(int s){
      return (++s);
```

```
}
void producer(){
     mutex = wait(mutex);
     full = signal(full);
     empty = wait(empty);
     x++;
     printf("\nProducer produces the item %d", x);
     mutex = signal(mutex);
}
void consumer() {
    mutex = wait(mutex);
    full = wait(full);
    empty = signal(empty);
    printf("\nConsumer consumes item %d", x);
    x--;
    mutex = signal(mutex);
 }
```

**Output:**

```
1.Producer
2.Consumer
3.Exit
Enter your choice:2
Buffer is empty!!
Enter your choice:1

Producer produces the item 1
Enter your choice:1

Producer produces the item 2
Enter your choice:1

Producer produces the item 3
Enter your choice:1

Producer produces the item 4
Enter your choice:1

Producer produces the item 5
Enter your choice:1
Buffer is full!!
Enter your choice:2

Consumer consumes item 5
Enter your choice:2

Consumer consumes item 4
Enter your choice:2

Consumer consumes item 3
Enter your choice:2

Consumer consumes item 2
Enter your choice:2

Consumer consumes item 1
Enter your choice:
2
Buffer is empty!!
Enter your choice:3
Program execution completed.
```

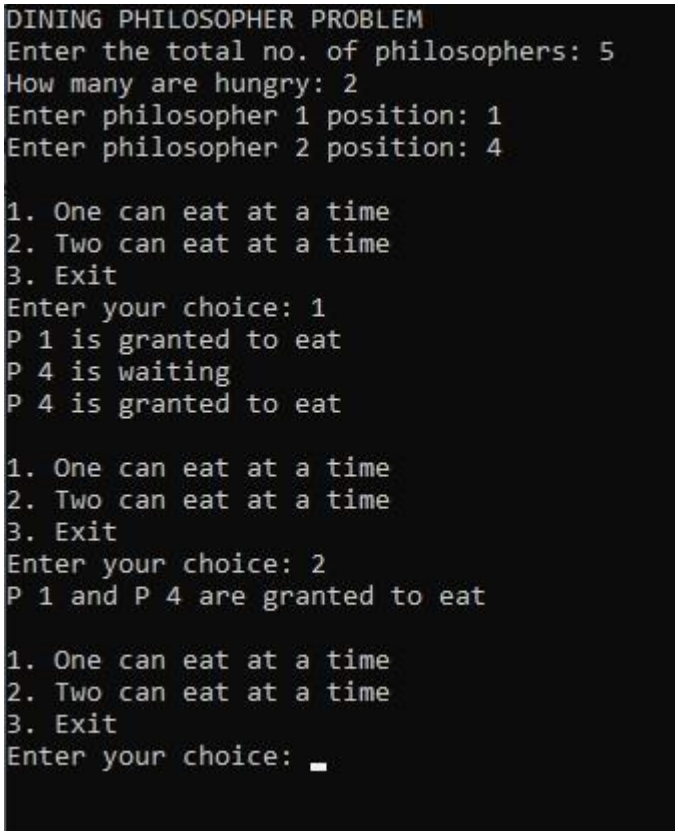
**6. Write a C program to simulate the concept of Dining-Philosophers problem.**

```
#include <stdio.h>
#include <stdlib.h>
#define MAX_PHILOSOPHERS 5
void allow_one_to_eat(int hungry[], int n) {
   int isWaiting[MAX_PHILOSOPHERS];
   for (int i = 0; i < n; i++) {
      isWaiting[i] = 1;
   }
   for (int i = 0; i < n; i++) {
      printf("P %d is granted to eat\n", hungry[i]);
      isWaiting[hungry[i]] = 0;
      for (int j = 0; j < n; j++) {
         if (isWaiting[hungry[j]]) {
            printf("P %d is waiting\n", hungry[j]);
         }
      }
      for (int k = 0; k < n; k++) {
         isWaiting[k] = 1;
      }
      isWaiting[hungry[i]] = 0;
   }
}
void allow_two_to_eat(int hungry[], int n) {
   if (n < 2 || n > MAX_PHILOSOPHERS) {
      printf("Invalid number of philosophers.\n");
      return;
   }
   for (int i = 0; i < n - 1; i++) {
      for (int j = i + 1; j < n; j++) {
         printf("P %d and P %d are granted to eat\n", hungry[i], hungry[j]);
```

```
            for (int k = 0; k < n; k++) {
                if (k != i && k != j) {
                    printf("P %d is waiting\n", hungry[k]);
                }
            }
        }
    }
}
int main() {
    int total_philosophers, hungry_count;
    int hungry_positions[MAX_PHILOSOPHERS];
    printf("DINING PHILOSOPHER PROBLEM\n");
    printf("Enter the total no. of philosophers: ");
    scanf("%d", &total_philosophers);
    if (total_philosophers > MAX_PHILOSOPHERS || total_philosophers < 2) {
        printf("Invalid number of philosophers.\n");
        return 1;
    }
    printf("How many are hungry: ");
    scanf("%d", &hungry_count);
    if (hungry_count < 1 || hungry_count > total_philosophers) {
        printf("Invalid number of hungry philosophers.\n");
        return 1;
    }
    for (int i = 0; i < hungry_count; i++) {
        printf("Enter philosopher %d position: ", i + 1);
        scanf("%d", &hungry_positions[i]);
        if (hungry_positions[i] < 0 || hungry_positions[i] >= total_philosophers) {
            printf("Invalid philosopher position.\n");
            return 1;
        }
```

```
    }
    int choice;
    while (1) {
        printf("\n1. One can eat at a time\n");
        printf("2. Two can eat at a time\n");
        printf("3. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);
        switch (choice) {
            case 1:
                allow_one_to_eat(hungry_positions, hungry_count);
                break;
            case 2:
                allow_two_to_eat(hungry_positions, hungry_count);
                break;
            case 3:
                exit(0);
            default:
                printf("Invalid choice\n");
        }
    }
    return 0;
}
```

**Output:**




**7. Write a C program to simulate Bankers algorithm for the purpose of deadlock avoidance.**

```
#include <stdio.h>
int main() {
   int n, m;
   printf("Enter the number of processes: ");
   scanf("%d", &n);
   printf("Enter the number of resources: ");
   scanf("%d", &m);
   int available[m];
   printf("Enter the available resources: ");
   for (int i = 0; i < m; i++) {
      scanf("%d", &available[i]);
   }
   int maximum[n][m];
   printf("Enter the maximum resources for each process:\n");
   for (int i = 0; i < n; i++) {
```

```
    for (int j = 0; j < m; j++) {
        scanf("%d", &maximum[i][j]);
    }
}
int allocation[n][m];
printf("Enter the allocated resources for each process:\n");
for (int i = 0; i < n; i++) {
    for (int j = 0; j < m; j++) {
        scanf("%d", &allocation[i][j]);
    }
}
int need[n][m];
for (int i = 0; i < n; i++) {
    for (int j = 0; j < m; j++) {
        need[i][j] = maximum[i][j] - allocation[i][j];
    }
}
printf(" Process   Allocation   Max   Need        \n");
for (int i = 0; i < n; i++) {
    printf("| P%d      | ", i + 1);
    for (int j = 0; j < m; j++) {
        printf("%d ", allocation[i][j]);
    }
    printf("| ");
    for (int j = 0; j < m; j++) {
        printf("%d ", maximum[i][j]);
    }
    printf("| ");
    for (int j = 0; j < m; j++) {
        printf("%d ", need[i][j]);
    }
```

```
    printf("|\n");
}
int work[m];
for (int i = 0; i < m; i++) {
    work[i] = available[i];
}
int finish[n];
for (int i = 0; i < n; i++) {
    finish[i] = 0;
}
int safeSequence[n];
int count = 0;
int safe = 1;
while (count < n) {
    int found = 0;
    for (int i = 0; i < n; i++) {
        if (finish[i] == 0) {
            int j;
            for (j = 0; j < m; j++) {
                if (need[i][j] > work[j]) {
                    break;
                }
            }
            if (j == m) {
                for (j = 0; j < m; j++) {
                    work[j] += allocation[i][j];
                }
                finish[i] = 1;
                safeSequence[count++] = i;
                found = 1;
            }
```

```
            }
        }
        if (!found) {
            safe = 0;
            break;
        }
    }
    if (safe) {
        printf("The system is in a safe state.\n");
        printf("Safety sequence: ");
        for (int i = 0; i < n; i++) {
            printf("P%d ", safeSequence[i] + 1);
        }
        printf("\n");
    } else {
        printf("The system is in an unsafe state and might lead to deadlock.\n");
    }
    return 0;
}
```

**Output:**

```
Enter the number of processes: 5
Enter the number of resources: 3
Enter the available resources: 3 3 2
Enter the maximum resources for each process:
7 5 3
3 2 2
9 0 2
2 2 2
4 3 3
Enter the allocated resources for each process:
0 1 0
3 0 2
3 0 2
2 1 1
0 0 2
 Process   Allocation   Max   Need
| P1      | 0 1 0 | 7 5 3 | 7 4 3 |
| P2      | 3 0 2 | 3 2 2 | 0 2 0 |
| P3      | 3 0 2 | 9 0 2 | 6 0 0 |
| P4      | 2 1 1 | 2 2 2 | 0 1 1 |
| P5      | 0 0 2 | 4 3 3 | 4 3 1 |
The system is in a safe state.
Safety sequence: P2 P3 P4 P5 P1

Process returned 0 (0x0)   execution time : 62.329 s
Press any key to continue.
```

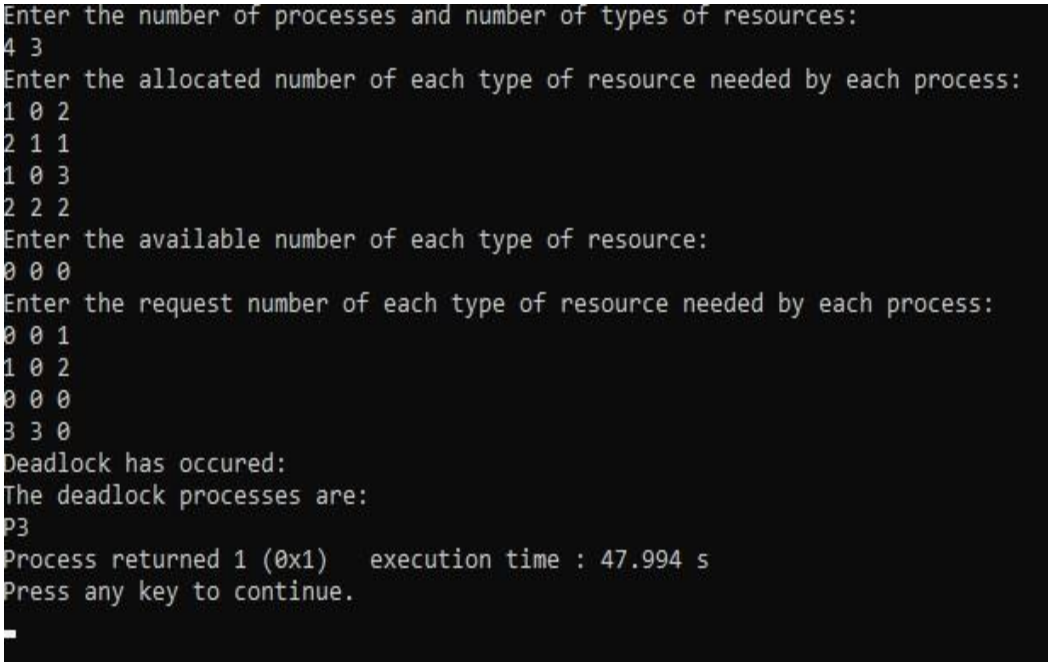
**8. Write a C program to simulate deadlock detection**

```
#include<stdio.h>
void main(){
   int n,m,i,j;
   printf("Enter the number of processes and number of types of resources:\n");
   scanf("%d %d",&n,&m);
   int max[n][m],need[n][m],all[n][m],ava[m],flag=1,finish[n],dead[n],c=0;
   printf("Enter the maximum number of each type of resource needed by each process:\n");
   for(i=0;i<n;i++){
      for(j=0;j<m;j++){
         scanf("%d",&max[i][j]);
      }
   }
   printf("Enter the allocated number of each type of resource needed by each process:\n");
   for(i=0;i<n;i++){
      for(j=0;j<m;j++){
```

```
        scanf("%d",&all[i][j]);
    }
}
printf("Enter the available number of each type of resource:\n");
for(j=0;j<m;j++){
    scanf("%d",&ava[j]);
}
for(i=0;i<n;i++){
    for(j=0;j<m;j++)
    {
        need[i][j]=max[i][j]-all[i][j];
    }
}
for(i=0;i<n;i++){
    finish[i]=0;
}
while(flag){
    flag=0;
    for(i=0;i<n;i++){
        c=0;
        for(j=0;j<m;j++){
            if(finish[i]==0 && need[i][j]<=ava[j]){
                c++;
                if(c==m){
                    for(j=0;j<m;j++){
                        ava[j]+=all[i][j];
                        finish[i]=1;
                        flag=1;
                    }
                    if(finish[i]==1){
                        i=n;
```

```
                }
            }
        }
    }
  }
  j=0;
  flag=0;
  for(i=0;i<n;i++){
    if(finish[i]==0){
      dead[j]=i;
      j++;
      flag=1;
    }
  }
  if(flag==1){
    printf("Deadlock has occured:\n");
    printf("The deadlock processes are:\n");
    for(i=0;i<n;i++){
      printf("P%d ",dead[i]);
    }
  }
  else
  printf("No deadlock has occured!\n");
}
```

**Output:**




**9.Write a C program to simulate the following contiguous memory allocation techniques**

**a) Worst-fit**

**b) Best-fit**

**c) First-fit**

```
#include <stdio.h>
struct Block {
   int block_no;
   int block_size;
   int is_free;
};
struct File {
   int file_no;
   int file_size;
};
void firstFit(struct Block blocks[], int n_blocks, struct File files[], int n_files) {
   printf("Memory Management Scheme - First Fit\n");
   printf("File_no:\tFile_size:\tBlock_no:\tBlock_size:\tFragment\n");
   for (int i = 0; i < n_files; i++) {
```

```
        for (int j = 0; j < n_blocks; j++) {
            if (blocks[j].is_free && blocks[j].block_size >= files[i].file_size) {
                blocks[j].is_free = 0;
                printf("%d\t\t%d\t\t%d\t\t%d\t\t%d\n", files[i].file_no, files[i].file_size, blocks[j].block_no,
blocks[j].block_size, blocks[j].block_size - files[i].file_size);
                break;
            }
        }
    }
}
void worstFit(struct Block blocks[], int n_blocks, struct File files[], int n_files) {
    printf("Memory Management Scheme - Worst Fit\n");
    printf("File_no:\tFile_size:\tBlock_no:\tBlock_size:\tFragment\n");
    for (int i = 0; i < n_files; i++) {
        int worst_fit_block = -1;
        int max_fragment = -1;
        for (int j = 0; j < n_blocks; j++) {
            if (blocks[j].is_free && blocks[j].block_size >= files[i].file_size) {
                int fragment = blocks[j].block_size - files[i].file_size;
                if (fragment > max_fragment) {
                    max_fragment = fragment;
                    worst_fit_block = j;
                }
            }
        }
        if (worst_fit_block!= -1) {
            blocks[worst_fit_block].is_free = 0;
            printf("%d\t\t%d\t\t%d\t\t%d\t\t%d\n", files[i].file_no, files[i].file_size,
blocks[worst_fit_block].block_no, blocks[worst_fit_block].block_size, max_fragment);
        }
    }
}
```

```
void bestFit(struct Block blocks[], int n_blocks, struct File files[], int n_files) {
    printf("Memory Management Scheme - Best Fit\n");
    printf("File_no:\tFile_size:\tBlock_no:\tBlock_size:\tFragment\n");
    for (int i = 0; i < n_files; i++) {
        int best_fit_block = -1;
        int min_fragment = 10000;
        for (int j = 0; j < n_blocks; j++) {
            if (blocks[j].is_free && blocks[j].block_size >= files[i].file_size) {
                int fragment = blocks[j].block_size - files[i].file_size;
                if (fragment < min_fragment) {
                    min_fragment = fragment;
                    best_fit_block = j;
                }
            }
        }
        if (best_fit_block!= -1) {
            blocks[best_fit_block].is_free = 0;
            printf("%d\t\t%d\t\t%d\t\t%d\t\t%d\n", files[i].file_no, files[i].file_size,
blocks[best_fit_block].block_no, blocks[best_fit_block].block_size, min_fragment);
        }
    }
}
int main() {
    int n_blocks, n_files;
    printf("Enter the number of blocks: ");
    scanf("%d", &n_blocks);
    printf("Enter the number of files: ");
    scanf("%d", &n_files);
    struct Block blocks[n_blocks];
    for (int i = 0; i < n_blocks; i++) {
        blocks[i].block_no = i + 1;
        printf("Enter the size of block %d: ", i + 1);
```

```
        scanf("%d", &blocks[i].block_size);
        blocks[i].is_free = 1;
    }
    struct File files[n_files];
    for (int i = 0; i < n_files; i++) {
        files[i].file_no = i + 1;
        printf("Enter the size of file %d: ", i + 1);
        scanf("%d", &files[i].file_size);
    }
    firstFit(blocks, n_blocks, files, n_files);
    printf("\n");
    for (int i = 0; i < n_blocks; i++) {
        blocks[i].is_free = 1;
    }
    worstFit(blocks, n_blocks, files, n_files);
    printf("\n");
    for (int i = 0; i < n_blocks; i++) {
        blocks[i].is_free = 1;
    }
    bestFit(blocks, n_blocks, files, n_files);
    return 0;
}
```

**Output:**

```
Enter the number of blocks: 3
Enter the number of files: 2
Enter the size of block 1: 5
Enter the size of block 2: 2
Enter the size of block 3: 7
Enter the size of file 1: 1
Enter the size of file 2: 4
Memory Management Scheme - First Fit
File_no:        File_size:      Block_no:       Block_size:     Fragment
1               1               1               5               4
2               4               3               7               3

Memory Management Scheme - Worst Fit
File_no:        File_size:      Block_no:       Block_size:     Fragment
1               1               3               7               6
2               4               1               5               1

Memory Management Scheme - Best Fit
File_no:        File_size:      Block_no:       Block_size:     Fragment
1               1               2               2               1
2               4               1               5               1

Process returned 0 (0x0)   execution time : 38.325 s
Press any key to continue.
```

10. **write a c program to stimulate page replacement algorithms**

**a)FIFO**

**b)LRU**

**c)Optimal**

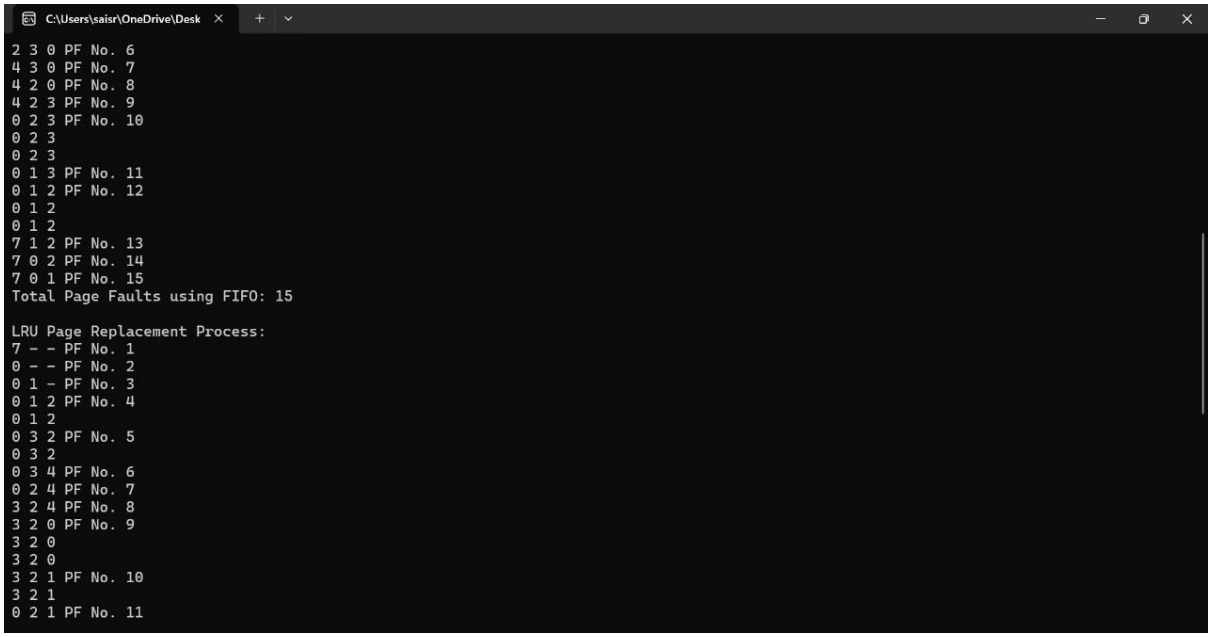
```
#include <stdio.h>
#include <limits.h>
#include <stdlib.h>

void print_frames(int frame[], int capacity, int page_faults) {
   for (int i = 0; i < capacity; i++) {
      if (frame[i] == -1)
         printf("- ");
      else
         printf("%d ", frame[i]);
   }
   if (page_faults > 0)
      printf("PF No. %d", page_faults);
   printf("\n");
}

void fifo(int pages[], int n, int capacity) {
   int frame[capacity], index = 0, page_faults = 0;
   for (int i = 0; i < capacity; i++)
```

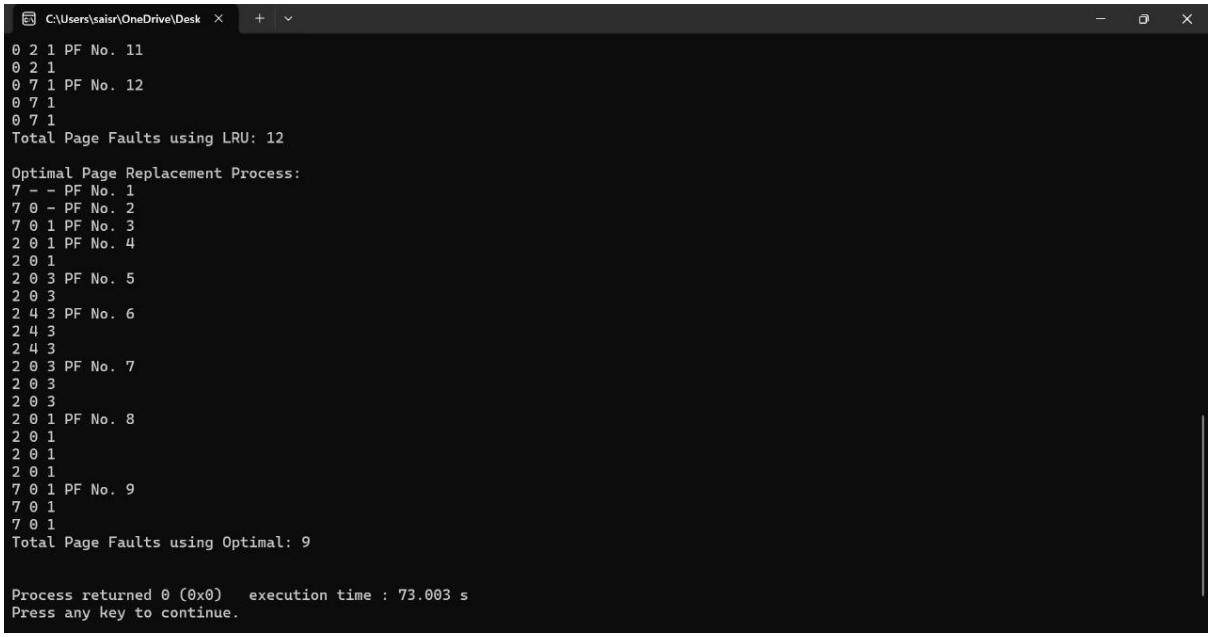
```
        frame[i] = -1;

    printf("FIFO Page Replacement Process:\n");
    for (int i = 0; i < n; i++) {
        int found = 0;
        for (int j = 0; j < capacity; j++) {
            if (frame[j] == pages[i]) {
                found = 1;
                break;
            }
        }
        if (!found) {
            frame[index] = pages[i];
            index = (index + 1) % capacity;
            page_faults++;
        }
        print_frames(frame, capacity, found ? 0 : page_faults);
    }
    printf("Total Page Faults using FIFO: %d\n\n", page_faults);
}

void lru(int pages[], int n, int capacity) {
    int frame[capacity], counter[capacity], time = 0, page_faults = 0;
    for (int i = 0; i < capacity; i++) {
        frame[i] = -1;
        counter[i] = 0;
    }

    printf("LRU Page Replacement Process:\n");
    for (int i = 0; i < n; i++) {
        int found = 0;
        for (int j = 0; j < capacity; j++) {
            if (frame[j] == pages[i]) {
                found = 1;
                counter[j] = time++;
                break;
            }
        }
        if (!found) {
            int min = INT_MAX, min_index = -1;
            for (int j = 0; j < capacity; j++) {
                if (counter[j] < min) {
                    min = counter[j];
                    min_index = j;
                }
            }
            frame[min_index] = pages[i];
            counter[min_index] = time++;
            page_faults++;
        }
        print_frames(frame, capacity, found ? 0 : page_faults);
```

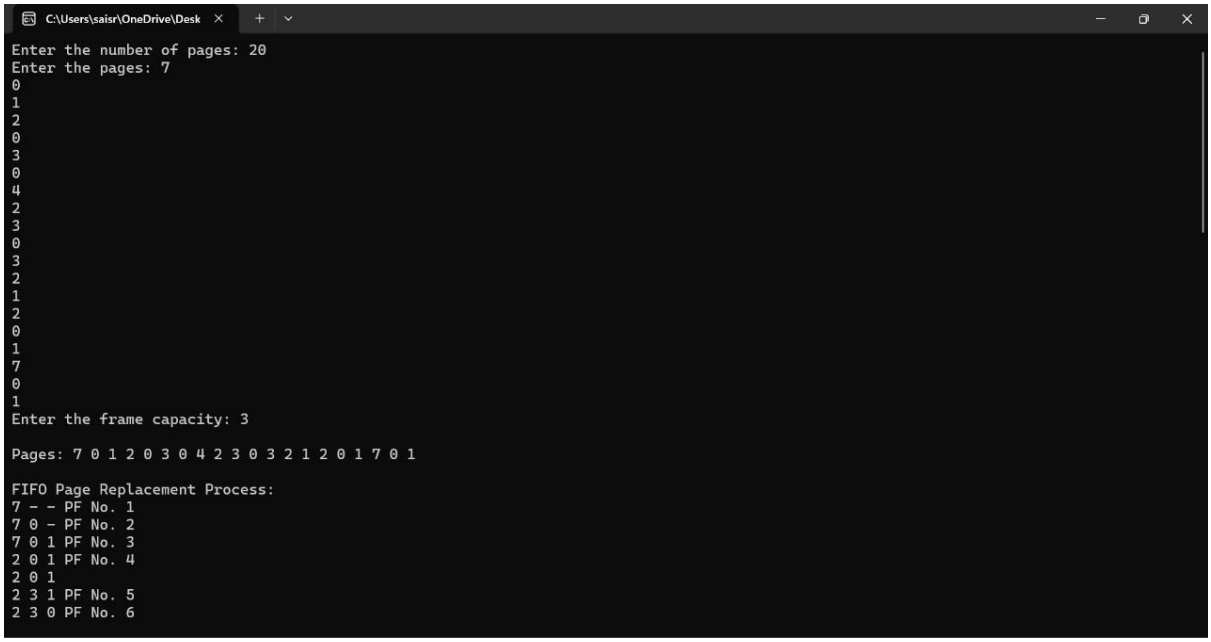
```
    }
    printf("Total Page Faults using LRU: %d\n\n", page_faults);
}

void optimal(int pages[], int n, int capacity) {
    int frame[capacity], page_faults = 0;
    for (int i = 0; i < capacity; i++)
        frame[i] = -1;

    printf("Optimal Page Replacement Process:\n");
    for (int i = 0; i < n; i++) {
        int found = 0;
        for (int j = 0; j < capacity; j++) {
            if (frame[j] == pages[i]) {
                found = 1;
                break;
            }
        }
        if (!found) {
            int farthest = i + 1, index = -1;
            for (int j = 0; j < capacity; j++) {
                int k;
                for (k = i + 1; k < n; k++) {
                    if (frame[j] == pages[k])
                        break;
                }
                if (k > farthest) {
                    farthest = k;
                    index = j;
                }
            }
            if (index == -1) {
                for (int j = 0; j < capacity; j++) {
                    if (frame[j] == -1) {
                        index = j;
                        break;
                    }
                }
            }
            frame[index] = pages[i];
            page_faults++;
        }
        print_frames(frame, capacity, found ? 0 : page_faults);
    }
    printf("Total Page Faults using Optimal: %d\n\n", page_faults);
}

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

```
    int *pages = (int*)malloc(n * sizeof(int));
    printf("Enter the pages: ");
    for (int i = 0; i < n; i++)
        scanf("%d", &pages[i]);
    printf("Enter the frame capacity: ");
    scanf("%d", &capacity);

    printf("\nPages: ");
    for (int i = 0; i < n; i++)
        printf("%d ", pages[i]);
    printf("\n\n");

    fifo(pages, n, capacity);
    lru(pages, n, capacity);
    optimal(pages, n, capacity);

    free(pages);
    return 0;
}
```

**Output :**




C:\Users\saisr\OneDrive\Desk
0 2 1 PF No. 11
0 2 1
0 7 1 PF No. 12
0 7 1
0 7 1
Total Page Faults using LRU: 12
Optimal Page Replacement Process:
7 - - PF No. 1
7 0 - PF No. 2
7 0 1 PF No. 3
2 0 1 PF No. 4
2 0 1
2 0 3 PF No. 5
2 0 3
2 4 3 PF No. 6
2 4 3
2 4 3
2 0 3 PF No. 7
2 0 3
2 0 3
2 0 1 PF No. 8
2 0 1
2 0 1
2 0 1
7 0 1 PF No. 9
7 0 1
7 0 1
Total Page Faults using Optimal: 9
Process returned 0 (0x0) execution time : 73.003 s
Press any key to continue.


C:\Users\saisr\OneDrive\Desk
Enter the number of pages: 20
Enter the pages: 7
0
1
2
0
3
0
4
2
3
0
3
2
1
2
0
1
7
0
1
Enter the frame capacity: 3
Pages: 7 0 1 2 0 3 0 4 2 3 0 3 2 1 2 0 1 7 0 1
FIFO Page Replacement Process:
7 - - PF No. 1
7 0 - PF No. 2
7 0 1 PF No. 3
2 0 1 PF No. 4
2 0 1
2 3 1 PF No. 5
2 3 0 PF No. 6

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10/7 Complete.

15/24

LAB-1

Scheduling programming Algorithm:

1) a) write a C program to stimulate the following non-pre-emptive cpu-scheduling algorithm to find turnaround time and waiting time.

```
#include <stdio.h>
#define Max_process 10;
void fcfs(int n, int at[], int bt[])
{
  int ct[Max_process];
  int tat[Max_process];
  int wt[Max_process];
  int total_wt=0;
  int total_tat=0;
  int current_time=0;
  for(i=0;i<n;i++)
    {
      ct[i]=-1;
    }
  for(int i=0;i<n;i++)
  {
    if(current_time<at[i])
    {
      current_time=at[i];
    }
    ct[i]=current_time+bt[i];
    current_time=ct[i];
  }
  for(int i=0;i<n;i++)
  {
    tat[i]=ct[i]-at[i];
    total_tat=total_tat+tat[i];
```

```
for (int i=0 ;i<n ;i++)
{
wt[i] = tat[i] - bt[i];
totalwt = totalwt + wt[i];
}
printf("\n process \t Arrival time \t Burst time
\t completion time \t Turnaround time \t
waiting time\n");
for (i=0;i<n ;i++)
{
printf("P%d \t %d \t %d \t %d \t %d \t %d \n",
i+1, at[i], bt[i], ct[i], tat[i], wt[i]);
}
printf("\n Average waiting time: %f",
(float)total_wt/n);
printf("\n Average turnaround time: %.2f",
(float)total_tat/n);
}
int main()
{
int n, i;
printf("Enter the number of processes:");
scanf("%d", &n);
int at[n], bt[n];
printf("Enter the arrival time:\n");
for(i=0;i<n ;i++)
{
scanf("%d", &at[i]);
}
Printf("enter the burst time:\n");
for(i=0;i<n ;i++){
scanf("%d", &bt[i]);
}sort(n, at, bt);
return 0;
```

Output:

Enter the number of processes: 4

Enter the arrival time:

0

1

5

6

Enter the brust time

2

2

3

4

| process | Arrival time | Brust time | completion time | Turnaround time | waiting time |
|---|---|---|---|---|---|
| $P_1$ | 0 | 2 | 2 | 2 | 0 |
| $P_2$ | 1 | 2 | 4 | 3 | 1 |
| $P_3$ | 5 | 3 | 8 | 3 | 6 |
| $P_4$ | 6 | 4 | 12 | 6 | 2 |

Average waiting time: 0.75

Average turnaround time: 3.50

8/5/24

b) SJF Non-preemptive

```
#include <stdio.h>
int main()
{
 int n, i, j, temp1, temp2;
 float atat = 0, awt = 0;
  printf(" enter the number of processes: ");
  scanf("%d", &n);
  int atime1[n], btime2[n], ctime3[n], tattime4[n], wtime5[n], pid[n];
  printf("Enter Process IDs :");
  for(i=0; i<n; i++)
  {
   scanf("%d", &pid[i]);
  }
  printf("enter the arrival times:");
  for(i=0; i<n; i++)
  {
   scanf("%d", &atime1[i]);
  }
  printf("enter burst times:");
  for(i=0; i<n; i++)
   {
    scanf("%d", &btime2[i]);
   }
  for(i=0; i<n-1; i++)
   {
    for(j=0; j<n-i-1; j++)
   }
    if(btime2[j] < btime2[j+1])
     {
      temp1 = btime2[j];
```

```
btime2[j]= btime2[j+1];
btime2[j+1]= temp1;
temp2 = pid[j];
pid[j] = pid[j+1];
pid[j+1]=temp2;
}
}
}
for(i=0; i<n; i++)
{
if(i==0)
{
ctime3[i] = atime1[i] + btime2[i];
}
else
{
if(ctime3[i-1]<atime1[i])
{
ctime3[i]=atime1[i]-ctime3[i-1]+ctime3[i-1]+
btime2[i];
}
else
{
ctime3[i] = ctime3[i-1]+ btime2[i];
}
}
}
for(i=0; i<n ;i++)
{
tattime4[i] = ctime3[i]-atime1[i];
}
```

```
for(i=0;i<n;i++)
{
 wtime5[i]=tat-time4[i]-btime2[i];
}
for(i=0;i<n;i++)
 {
  atat=atat+tat-time4[i];
 }
 atat=(atat/n);
for(i=0;i<n;i++)
 {
  awt=awt+wtime5[i];
 }
awt=(awt/n);
for(i=0;i<n;i++)
{
printf("process id %d Arrival Time %d, Burst time %d
complete Time %d, Turn Around Time %d, waiting Time %d\n",
pid[i],atime1[i],btime2[i],ctime3[i],tat time4[i],
wtime5[i]);
 }
printf("Average Turn Around time: %f\n",atat);
printf("Average waiting Time : %f\n",awt);
 return 0;
 }
```

Output:

| Process ID | Arrival time | Burst time | completion Time | Turnaround time | waiting time |
|---|---|---|---|---|---|
| P1 | 0 | 6 | 9 | 9 | 3 |
| P2 | 0 | 8 | 24 | 24 | 16 |
| P3 | 0 | 7 | 16 | 16 | 9 |
| P4 | 0 | 3 | 3 | 3 | 0 |
| P5 | | | | | |

Average of TurnAroundtime = 13

Average of waiting time = 7

c) Pre-emptive

```
#include <stdio.h>
#define MAX 10

int find_min(int arr[], int n)
{
  int min = arr[0];
  int index = 0;
  for(int i = 1; i < n; i++)
  {
    if (arr[i] < min)
    {
      min = arr[i];
      index = i;
    }
  }
  return index;
}
```

```
void sjf_preemptive (int n, int at[], int bt[]);
{
  int ct[MAX]={0};
  int tat[MAX]={0};
  int wt[MAX]={0};
  int rt[MAX];
  int total_wt=0;
  int total_tat=0;
  for (int i=0; i<n; i++)
  {
    rt[i]=bt[i];
  }
  int current_time=0;
  int completed_processes=0;
  while (completed_processes<n);
  {
    int available_processes[MAX];
    int available_count=0;
    for (int i=0; i<n; i++)
    {
      if (at[i]<=current_time && rt[i]>0);
{
    available_processes[available_count]=i;
      available_count++;
      continue;
    }
  int shortest_job_index=available_processes
    [find_min (rt, available_count)];
  rt[shortest_job_index]--;
    current_time++;
```

```
if (rt[shortest_job_index] == 0)
{
completed++, processes++;
ct[shortest_job_index] = current_time;
tat[shortest_job_index] = ct[shortest_job_index] -
    at[shortest_job_index];
wt[shortest_job_index] = tat[shortest_job_index] -
    bt[shortest_job_index];
total_wt += wt[shortest_job_index];
total_tat += tat[shortest_job_index];
}
}
Printf("\n process \t Arrival Time \t Burst Time \t
completion time \t Turn around time \t waiting time
for(int i=0; i<n; i++)
{
printf("%d \t %d \t %d \t %d \t %d \t %d \n", i+1,
at[i], bt[i], ct[i], tat[i], wt[i]);
}
printf("\n Average waiting time : %.2f", (float)
total_wt/n);
printf("\n Average turnaround time : %.2f", (float)
total_tat/n);
}
int main()
{
int n;
Printf("Enter the number of processes:");
scanf("%d", &n);
Int at[Max], bt[Max];
printf("Enter the arrival time:\n");
```

```
scanf("%d",&n);
int at[max], bt[max],
printf("Enter the arrival time:\n");
for(int i=0;i<n;i++)
{
scanf("%d",&at[i]);
}
Printf("Enter the burst time:\n");
Scanf("%d",&bt[i]);
}
if preemptive(n,at,bt)
return 0;
}
```

| process ID | Arrival time | Burst time | CT | TAT | WT |
|---|---|---|---|---|---|
| P1 | 2 | 1 | 3 | 1 | 0 |
| P2 | 1 | 5 | 7 | 6 | 1 |
| P3 | 4 | 1 | 8 | 4 | 3 |
| P4 | 0 | 6 | 13 | 13 | 7 |
| P5 | 2 | 3 | 16 | 14 | 11 |

Average waiting time : 4.40
Average turnaround time : 7.60

5/5/24 LAB-2

a) Priority Non-preemtive

```
#include <stdio.h>
#define MAX 10

void Priority_non_preemptive(int n, int at[], int bt[],
int P[]){
 int at[MAX] = {0};
 int tat[MAX] = {0};
 int wt[MAX] = {0};
 int total_wt = 0;
 int total_tat = 0;

 int bt_copy[MAX];
 for(int i = 0; i < n; i++)
 {
   bt_copy[i] = bt[i];
 }
 for(int i = 0; i < n; i++)
 }
 for(int j = i+1; j < n; j++)
 {
   if(P[i] < P[j])
   {
   int temp = at[i];
   at[i] = at[j];
   at[j] = temp;
   temp = bt[i];
   bt[i] = bt[j];
   bt[j] = temp;
   temp = P[i];
   P[i] = P[j];
   P[j] = temp;
  }
```

```
ct[0] = at[0]+bt[0];
tat[0] = ct[0]-at[0];
wt[0] = tat[0]-bt_copy[0];
total_wt+=wt[0];
total_tat+=tat[i];
}
printf("\n Process \t Arrival Time\t Brust time\t
 Completion time\t Turnaround time\t Waiting
 time\n");
for (int i=0;i<n ;i++)
  {
Printf("\n%d \t %d \t %d \t %d \t\t %d \t %d",i+1, at[i], bt_copy[i], ct[i], tat
[i], wt[i]);
 }
 printf("\n Average waiting time = %f", (float)
                                    wt/n);
 printf("\n Average turnaround time = %f",
        (float)total_tat/n);
 }
 int main()
 int n;
 printf(" Enter the number of processes:");
 scanf("%d",&n);
 int at[MAX], bt[MAX], p[MAX];
 printf("Enter the arrival time:\n");
 scanf("%d", &n);
 int at[MAX], bt[MAX], p[MAX];
 printf("Enter the arrival time:\n");
 for(int i=0; i<n; i++)
   scanf("%d", &at[i]);
 }
```

printf("enter the burst time:\n");
for(int i=0;i<n;i++)
{
scanf("%d",&bt[i]);
}

priority-non_preemptive(n,at,bt,p);
return 0;
}

output

| PID | priority | AT | BT | CT | TAT | WT | RT |
|---|---|---|---|---|---|---|---|
| P1 | 10 | 0 | 5 | 12 | 12 | 7 | 0 |
| P2 | 20 | 1 | 4 | 8 | 7 | 3 | 0 |
| P3 | 30 | 2 | 2 | 4 | 2 | 0 | 0 |
| P4 | 40 | 4 | 1 | 5 | 1 | 0 | 0 |

Average TAT = 5.5
Average WT = 2.5

15/5/24

b) Round Robin scheduling.

```
#include<stdio.h>
#define MAX 10
#define quantum 2
void round_robin (int n, int at[], int bt[])
{
  int ct[MAX]={0};
   int tat[MAX]={0};
  int wt[MAX]={0};
   int total_wt = 0;
   int total_tat = 0;
   int bt_copy [MAX];
   for (int i=0; i<n; i++)
   {
     bt_copy[i]=bt[i];
   }
   int time=0;
   int i=0;
   while (1)
{
   int done=1;
   for (int i=0; i<n; i++)
    {
     if (bt_copy[i]>0)
    {
     done=0;
     if (bt_copy[i]>quantum)
    {
      time = time + quantum;
      bt_copy[i] = bt_copy[i] - quantum;
    }
      else
        {
          time = time + bt_copy[i];
```

b

```
bt-copy[i]=0;
ct[i]= time;
tat[i]= ct[i]-at[i];
wt[i]= tat[i]-bt[i];
total_wt+= wt[i];
total_tat+= tat[i];
}
}
if (done)
break;
}
printf("\n process\t arrival time\t Burst time\t
completion time\t turn around time\t waiting
time\n");
for (int i=0; i<n; i++)
{
printf("%d\t %d\t %d\t %d\t %d\t %d\n",
i+1, at[i], bt[i], ct[i], tat[i], wt[i]);
}
printf("\n Average waiting time: %.2f", (float)
total_wt/n);
printf("\n Average turn around time: %.2f", (float)
total_tat/n);
}
int main()
{
```

```
int n;

printf("Enter the number of process");
scanf("%d", &n);
int at[max], bt[max];
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]);
}
round_robin(n, at, bt);
}
```

output:

Enter the number of process
5
Enter Arrival time
0
1
2
3
4
Enter the burst time
5
3
1

2

3

| Process | At | Bt | CT | TAT | WT |
|---|---|---|---|---|---|
| 1 | 0 | 5 | 14 | 14 | 9 |
| 2 | 1 | 3 | 12 | 11 | 8 |
| 3 | 2 | 1 | 5 | 3 | 2 |
| 4 | 3 | 2 | 7 | 4 | 2 |
| 5 | 4 | 3 | 13 | 9 | 6 |

Average WT : 5.40

Average TAT : 8.20

5/6/24

LAB-3 Program.

Multilevel queue //

```
#include<stdio.h>
void findwaitingTime(int processes[], int n, int bt[], int at[],
int wt[])
{
 wt[0]=0;
 for(int i=1; i<n; i++)
  {
   wt[i]=bt[i-1]+wt[i-1]-at[i-1];
   if (wt[i]<0)
    wt[i]=0;
  }
}

void findTurnaroundTime(int processes[], int n, int bt[],
int wt[], int tat[])
{
 for(int i=0; i<n; i++)
  {
  tat[i]=bt[i]+wt[i];
 }
}

void RoundRobin(int Processes[] int n, int bt[],
int at[], int quantum)
 {
 int wt[n], tat[n], at[n] total_wt=0, total_tat=0;
 int remaining_bt[n];
  int completed=0;
 int time=0;
 for(int i=0; i<n; i++)
 {
 remaining_bt[i]=bt[i];
 }
```

```
while (completed < n)
{
for (int i = 0; i < n; i++)
{
if (remaining_bt[i] > 0 && at[i] <= time)
{
if (remaining_bt[i] <= quantum)
{
time += remaining_bt[i];
remaining_bt[i] = 0;
ct[i] = time;
completed++;
}
else
{
time += quantum;
remaining_bt[i] -= quantum;
}
}
}
}
findwaitingTime(processes, n, bt, at, wt);
findTurnaroundTime(processes, n, bt, wt, tat);
printf("processes Brust time Arrival time waiting time
Turn Around time completion time \n");
for (int i = 0; i < n; i++)
{
printf("%d %d %d %d %d %d %d\n", processes[i],
at[i], wt[i], tat[i], ct[i]);
totalwt += wt[i];
total tat += tat[i];
}
```

```
printf ("Average waiting Time (Round Robin)=%.f\n",
(float) total_wt / n);
printf ("Average Turn Around time (Round Robin)=%.f\n",
(float) total_tat / n);
}
void fcfs(int processes[], int n, int bt[], int at[])
{
int wt[n], tat[n], ct[n], total_wt=0, total_tat=0;
findwaiting Time (processes, n, bt, at, wt);
findTurnaround time (processes, n, bt, wt, tat);
printf ("processes Burst time Arrival Time waiting time
Turnaround Time completion Time\n");
for (int i=0; i<n; i++)
{
ct[i]=at[i]+bt[i];
printf ("P%.d\t\t%.d\t\t%.d\t\t%.d\t\t%.d\t\t%.d\n",
process[i], bt[i], at[i], wt[i], tat[i], ct[i]);
total_wt += wt[i];
total_tat += tat[i];
}
printf ("Average waiting Time (FCFS)=%.d\n", (float)
total_wt / n);
printf ("Average Turnaround Time (FCFS)=%.d\n", (float)
total_tat / n);
}
```

```
int main()
{
int processes[] = {1, 2, 3, 4, 5};
int n = sizeof(processes) / sizeof(processes[0]);
int bt = {10, 5, 8, 12, 15};
int at[] = {0, 1, 2, 3, 4};
int quantum = 2;
roundRobin(processes, n, bt, at, quantum);
fcfs(processes, n, bt, at);
return 0;
}
```

Output

| Process | BT | AT | WT | Tat | CT |
|---|---|---|---|---|---|
| P1 | 10 | 0 | 0 | 10 | 39 |
| P2 | 5 | 1 | 10 | 15 | 23 |
| P3 | 8 | 2 | 14 | 22 | 33 |
| P4 | 12 | 3 | 20 | 32 | 45 |
| P5 | 15 | 4 | 29 | 44 | 50 |

Avg WT (Round Robin) = 14.60

Avg Turnaroundtime (Round Robin) = 24.60

| Process | BT | AT | WT | Tat | CT |
|---|---|---|---|---|---|
| P1 | 10 | 0 | 0 | 10 | 10 |
| P2 | 5 | 1 | 10 | 15 | 6 |
| P3 | 8 | 2 | 14 | 22 | 10 |
| P4 | 12 | 3 | 20 | 32 | 19 |
| P5 | 15 | 4 | 29 | 44 | |

Avg wt (FCFS) = 14.60

Avg Tat (FCFS) = 24.6

5/6/24

# 4 A A Program.

a) Rate Monotonic //

```
#include <stdio.h>
Struct process {
  int execution_time;
  int time_period;
};
int lcm(int a, int b)
{
  int max = (a>b)? a: b;
  while(1)
  {
   if (max%a==0 && max%b==0)
    return max;
    max++;
   }
}
int is_schedulable (Struct process processes[], int n)
{
  float utilization = 0.0;
  for(int i=0; i<n; i++)
  {
   utilization += (float) processes[i].execution_time/
   processes[i].time_period;
  }
  return utilization <= 1.0;
}
int main()
{
  Struct process processes[] =
    {
     {3, 20},
     {2, 5},
     {2, 10}
    };
```

```
int n= sizeof (processes) /sizeof(processes[0]);
if (!is_schedulable(processes,n))
 {
  printf(" The given set of processes is not
   schedule.\n");
  return 0;
  }
int scheduling_time =lcm(processes[0].time_period,
processes[1].time_period);
Scheduling_time =lcm(Scheduling_time ,Processes[2].
 time_period);
printf("Execution order: \n");
if (t+1.processes[1].time_period==0)
 printf("P2");
if (t+1.processes[2].time_period==0)
 printf("P3");
if (t+1.processes[0].time_period ==0)
 printf("P1");
 }
printf("\n");
return 0;
};
```

output:

Execution order:

P2 P3 P1 P2 P2 P3 P2

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b) Earliest dead line first scheduling:

```
#include <stdio.h>
#include <stdlib.h>
#include <math.h>
void
Sort (int proc[], int d[], int b[], int pt[],
int n)
{
int temp p = 0;
for (int i=0; i<n; i++)
{
for (int j = i ; j<n ; j++)
 {
  if (d[j]<d[i])
   {
   temp=d[j];
   d[j] = d[i];
   d[i] = temp;
   temp = pt[i];
   pt[i] = pt[j];
   pt[j] = temp;
   temp = b[j];
   b[j] = b[i];
   b[i] = temp;
   temp = Proc[i];
   proc[i] = proc[j];
   proc[j] = temp;
   }
 }
}
}
```

```
int gcd (int a, int b)
  {
   int r;
   while (b>0)
   {
   r = a%b;
   a=b;
   b=r;
   }
   return a;
  }
int
lcmul (int p[], int n)
{
int lcm = p[0];
for(int i=1;i<n;i++);
{
  lcm=( lcm*p[i])/gcd (lcm, p[i]);
}
return lcm;
}
void main()
{
int n;
printf ("Enter the number of processes:");
scanf("%d",&n);
int proc[n], b[n], p[n],d[n],rem[n];
printf ("Enter the cpu burst times:\n");
for(int i=0;i<n;i++)
   {
   scanf("%d",&b[i]);
```

```
rem[i]=b[i];
}
printf("Enter the deadlines:\n");
for(int i=0; i<n; i++)
 scanf("%d",&d[i]);
printf("Enter the time periods:\n");
for(int i=0; i<n; i++)
 scanf("%d",&pt[i]);
for(int i=0;i<n;i++)
proc[i]=i+1;
sort(proc,d,b,pt,n);
 int l=lcmul(pt,n)
 printf("\n Earliest deadline Scheduling:\n");
printf("\nPROCESS Burst time deadline time period\n");
for(int i=0;i<n;i++)
 printf("\n %d\t\t %d\t\t %d\t\t %d\t\t %d",proc[i],b[i],
d[i],pt[i]);
 printf("\nScheduling occurs for %d ms\n\n",l);
 int time=0,prev=0,x=0;
 int next_deadlines[n];
 for(int i=0;i<n;i++)
  {
   next_deadlines[0];
   for(int i=0;i<n;i++)
    {
     next_deadlines[i]=d[i];
     rem[i]=b[i];
    }
   while(time<l)
   {
    for(int i=0;i<n;i++)
```

```
{
 if (time % pt[i] == 0 && time != 0)
 {
  nextDeadlines[i] = time + d[i];
  rem[i] = b[i];
 }
}
int minDeadline = INT_MAX;
int taskToExecute = -1;
for (int i = 0; i < n; i++)
 {
  if (rem[i] > 0 && nextDeadlines[i] < minDeadline)
  {
   minDeadline = nextDeadlines[i];
   taskToExecute = i;
  }
 }
if (taskToExecute != -1)
 {
  printf("%d ms: Task %d is running.\n", time, proc[taskToExecute]);
  rem[taskToExecute]--;
 }
 else
 {
  printf("%d ms: CPU is idle.\n", time);
 }
 time++;
 }
}
```

output:

Enter the number of process 3

Enter the CPU burst times:

3

2

2

Enter the deadlines:

7

4

8

Enter the time periods:

20

5

10

earliest deadline scheduling:

| PID | Burst | deadline | period |
|---|---|---|---|
| 2 | 2 | 4 | 5 |
| 3 | 3 | 7 | 20 |
| 1 | 2 | 8 | 10 |

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Scheduling occurs for 20ms

0ms: Task 2 is running

1ms: Task 2 is running

2ms: Task 1

3ms: Task 1

4ms: Task 4

5ms: Task 3

6ms: Task 3

7ms: Task 2

8ms: Task 1

9ms: cpu is idle

10ms: Task 2

11ms: Task 2

12ms: Task 3

13ms: Task 3

14ms: cpu is idle

15ms: Task 2

16ms: Task 2

17ms: cpu is idle

18ms: cpu is idle

19ms: cpu is idle

5/6/24

c) proportionality scheduling

```
#include <stdio.h>
#include <stdlib.h>
#include <time.h>
#define MAX_TASKS 10
#define MAX_TICKETS 100
#define TIME_UNIT_DURATION_MS 100

Struct Task {
    int tid;
    int tickets;
};
void schedule (Struct Task tasks[], int num_tasks,
int time_span_ms)
{
  int total_tickets=0;
  for (int i=0; i<num_tasks;i++)
   {
    total_tickets+= tasks[i].tickets;
  }
  Srand (time(NULL));
  int current_time=0;
  int completed_tasks=0;
  printf ("Process Scheduling:\n");
while (completed_tasks<num_tasks)
  {
   int winning_ticket = rand()% total_tickets;
   int cumulative_tickets=0;
  for (int i=0; i< num_tasks )
  {
   int winning_ticket = rand()% total_tickets;
```

```
int cumulative_tickets=0;
for(int i=0; i<num_tasks; i++)
{
  cumulative_tickets+=tasks[i].tickets;
if(winning_ticket<cumulative_tickets)
{
Printf("Time %d: %d: Task %d is running\n",
current_time,current_time+1,tasks[i].id);
current_time++)
  break;
}
}
  Completed_tasks++;
}
  *time_span_ms=current_time*TIME_UNIT_
DURATION_MS;
}
int main()
{
struct Task [MAX_TASKS];
  int num_tasks;
  int num_tasks;
  int time_span_ms;
Printf("Enter the number of tasks:");
 scanf("%d",&num_tasks);
if(num_tasks<=0 ||num_tasks>MAX_TASKS)
{
Printf("Invalid number of tasks. please enter a
number between 1 and %d\n",MAX_TASKS);
}
```

```
printf ("Enter number of tickets for each task:\n");
for (int i=0; i< num_tasks; i++)
{
tasks[i].tid=i+1;
   printf ("Task %d tickets : ", tasks[i].tid);
  scanf ("%d", &tasks[i].tickets);
}
printf ("\n Running tasks:\n");
Schedule(tasks, num_tasks, time_span_ms);
printf("\n Time span of the Gantt chart: %d milliseconds\n",
time_span_ms);
return 0;
}
```

Output:

Enter the number of tasks: 3

Enter number of tickets for each task:

Task 1 tickets: 10

Task 2 tickets: 5

Task 3 tickets: 20

Running tasks:

Process scheduling:

Time 0-1: Task 2 is running

Time 1-2: Task 3 is running

Time 2-3: Task 1 is running

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# LAB-5 program.

Write a c program to stimulate producer-consumer problem using semaphores

```
#include <stdio.h>
#include <stdlib.h>
int mutex=1,full=0,empty=5,x=0;
int main()
{
int n;
void producer();
void consumer();
int wait(int);
int signal(int);
printf("\n1. producer \n2. consumer \n3. Exit");
while(1)
{
printf("\n Enter your choice:");
scanf("%d",&n);
switch(n)
{
case 1:
if((mutex==1)&&(empty!=0))
producer();
else
printf("Buffer is full!!");
break;
case 2:
if((mutex==1)&&(full!=0))
consumer();
else
printf("Buffer is empty!!");
```

```
break;
case 3:
    exit(0);
    break;
  }
}
return 0;
}
int wait(int s)
{
 return(--s);
}
int signal(int s)
{
   return(++s);
}
void producer()
 {
   mutex = wait(mutex);
   full = signal(full);
   empty = wait(empty);
 x++;
printf("\n producer the item %d", x);
mutex = signal(mutex);
}
void consumer()
{
 mutex = wait(mutex);
 full = wait(full);
 empty = signal(empty);
 printf("\n Consumer consumes item %d", x);
```

x--;
mutex = signal (mutex);
}

Output:
1. producer
2. consumer
3. Exit
Enter your choice : 1
producer produces the item 1
Enter the your choice : 1
producer produces the item 2
Enter your choice : 1
producer produces the item 3
Enter your choice : 2
consumer consumes item 3.

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19/6/24 LAB-6 program.

⇒ write a C program to simulate Banker's algorithm for the purpose of deadlock avodance

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

#define Max-processes 10
#define Max-Resources 10
bool is safeState (int processes, int resources, int available
int max[][Max-RESOURCES], int allocation[]
 [Max-Resources], int need[] [MAX-RESOURCES], int
safe sequence []);
 int main()
{
int processes, resources;
int available [Max-Resources];
int max[Max-PROCESSES][Max-RESOURCES];
int allocation [Max-PROCESSES][Max-RESOURCES];
int need[Max-processes] [Max-RESOURCES];
int Safesequence[MAX-PROCESSES];
Printf ("Enter the number of processes:");
scanf("%d", &processes);
printf("Enter the number of resources:");
Scanf("%d", &resources);
Printf ("Enter the available resources:\n");
for(int i=0; i<resources; i++)
   {
    scanf("%d", &available[i]);
   }
Printf(" Enter the maximum resource matrix:\n");
for (int i=0; i<processes; i++)
```

```
{
printf("Enter details for p%d\n",i);
for (int j=0; j<resources; j++)
{
scanf("%d",&max[i][j]);
}
}
printf("Enter the allocation resource matrix:\n");
for(int i=0;i<processes;i++)
{
for(int j=0; j<resources; j++)
{
scanf("%d",&allocation[i][j]);
}
}
calculate need(processes, resources, max, allocation,
need);
if(issafestate(processes, resources, available, max,
allocation, need, safesequence))
{
printf("SYSTEM is IN SAFE STATE\n");
printf("The safe sequence is --(");
for(int i=0;i<processes;i++)
{
printf("P%d",safesequence[i]);
}
printf(")\n");
}
else
{
printf("System is NOT IN SAFE STATE\n");
}
```

```
Printf ("\n Process \t Allocation \t Max \t Need\n");
for(int i=0; i< processes; i++)
{
Printf ("P%d \t", i);
for (int j=0; j <resources; j++)
{
  Printf ("%d" xallocation[i][j]);
}
Printf("\t");
for(int j =0; j<resources ; j++)
  {
  printf("%d", max[i][j]);
}
Print f("\t");
for(int j=0 ; j< resources ; j++)
{
  printf("%d", need[i][j]);
}
printf("\n");
}
return 0;
}
void calculate need (int processes, int resources, int max
[max_Resources], int allocation[][max_resources], int
need[][Max:Resources];
{
  for (int i=0; i< processes ; i++)
  for (int j=0 ; j<resource  j< resources ; j++)
  {
  need[i][j]: max[i][j]-allocation[i][j];
  }
}
```

```
bool is_safe_state(int processes, int resources, int available,
int max[][MAX_RESOURCES], int allocation[]
[MAX_RESOURCES], int need[][MAX_RESOURCES], int
safe_sequence[]){
 int work[MAX_RESOURCES];
 bool finish[MAX_PROCESSES] = {false};
int count = 0;
for(int i=0; i<resources; i++)
  {
   work[i] = available[i];
  }
while(count < processes)
{
bool found = false;
for(int i=0; i<processes; i++)
{
 if(!finish[i])
 {
 bool canAllocate = true;
for(int j=0; j<resources; j++)
{
 if(need[i][j] > work[j])
  {
   canAllocate = false;
   break;
  }
}
if(canAllocate)
{
for(int j=0; j<resources; j++)
 {
  work[j] += allocation[i][j];
```

```
finish[i]=true;
Safesequence[count++]=i;
found=true;
printf("P%d is visited(", i);
for(int j=0;j<resources;j++)
{
printf("%d", work[j]);
}
printf("\n");
}
}
}
if(!found)
{
for(int i=0; i<processes; i++)
{
if(!finish[i])
{
return false;
}
}
return true;
}
}
return true;
}
```

output:

Enter the number of process: 5
Enter the number of resources: 3
Enter the ~~number of~~ available resources:
3 3 2
Enter the maximum resource matrix:
Enter details for $P_0$
7 5 3
Enter details for $P_1$
3 2 2
Enter details for $P_2$
9 0 2
Enter details for $P_3$
2 2 2
Enter details for $P_4$
4 3 3
Enter the allocation resource matrix:
0 1 0
2 0 0
3 0 2
2 1 1
0 0 2
$P_1$ is visited (5 3 2)
$P_3$ is visited (7 4 5)
$P_4$ is visited (7 4 5)
$P_0$ is visited (7 5 5)
$P_2$ is visited (10 5 7)
System is in safe state.
The safe sequence is - (P1 P3 P4 P0 P2)

| Process | Allocation | Max | Need |
|---|---|---|---|
| P0 | 0 1 0 | 7 5 3 | 7 4 3 |
| P1 | 2 0 0 | 3 2 2 | 1 2 2 |
| P2 | 3 0 2 | 9 0 2 | 6 0 0 |
| P3 | 2 1 1 | 2 2 2 | 0 1 1 |
| P4 | 0 0 2 | 4 3 3 | 4 3 1 |

Lt 8-7 Program

19/6/24

Dining Philosopher

```
#include <stdio.h>
#include <stdlib.h>
#define MAX_PHILOSOPHERS 5
Void allow_one_to_eat(int hungry[], int n)
{
 int is_waiting[MAX_PHILOSOPHERS];
for(int i=0;i<n;i++)
 {
   is_waiting[i]=1;
 }
for(int i=0;i<n;i++)
{
printf("P.%d is granted to each eat\n", hungry[i]
is_waiting[hungry[i]]=0;
 for(int j=0;j<n;j++)
 {
  if(is_waiting[hungry[j]]
{
  printf("P.%d is waiting\n", hungry[j]);
```

```
}
}
for (int k=0;k<n;k++)
{
 is waiting[k]=1;
}
 is waiting[hungry[i]]=0;
}
}
void allow_two_to_eat(int hungry[], int n)
{
 if (n<2 || n>MAX_PHILOSOPHERS)
 {
   Printf("Invalid number of philosophers.\n");
   return n;
 }
for (int i=0; i<n-1;i++)
{
 for (int j=i+1;j<n;j++)
{
 Printf("P%d and P%d are granted to eat\n", hungry[i],
hungry[j]);
 for (int k=0;k<n;k++)
 {
 if ((k!=i)&&(k!=j))
  {
   Printf("p%d is waiting\n", hungry[k]);
  }
 }
}
}
```

```
int main()
{
int total_philosophers, hungry_count;
int hungry_positions[MAX_PHILOSOPHERS];
printf("DINING philosopher PROBLEM\n");
printf("Enter the total no. of philosophers: ");
scanf("%d", &total_philosophers);
if (total_philosophers > MAX_PHILOSOPHERS || total_philosophers
return 1;
}
printf("How many are hungry: ");
scanf("%d", &hungry_count);
if (hungry_count <1 || hungry_count > total_philosophers)
{
printf("Invalid number of hungry philosophers\n");
return 1;
}
for (int i=0; i<hungry_count; i++)
{
printf("Enter philosopher %d position: ", i+1);
scanf("%d", &hungry_positions[i]);
if (hungry_positions[i]<0 || hungry_positions[i]>=total_
philosophers)
{
printf("invalid philosopher position.\n");
return 1;
}
}
int choice;
while(1)
{
```

```
printf("\n 1. One can eat at a time \n");
printf("2. Two can eat at a time\n");
printf("3. Exit \n");
printf("Enter your choice:");
scanf("%d", &choice);
switch(choice){
case 1:
 allow_one_to_eat(hungry_positions, hungry_count);
 break;
case 2:
allow_two_to_eat(hungry_positions, hungry_count);
break;
case 3:
 exit(0);
 default:
  printf("Invalid choice\n");
 }
}
return 0;
}
```

```
Enter total no of philosophers: 5
How many are hungry: 2
Enter philosopher 1 position: 1
Enter philosopher 2 position: 4
1. One can eat at a time
2. Two can eat at a time
3. Exit
Enter your choice: 2
```

3/2/24 LAB 8 program:

8) write a c program to simulate deadlock detection

```
#include<stdio.h>
void main()
{
int n,m,i,j;
printf("enter the number of processes and number of
types of resources:\n");
scanf("%d%d",&n,&m);
int max[n][m],need[n][m],all[n][m],ava[m],flag=1,
finish[n],dead[n],c=0;
printf("enter the maximum number of each type
of resource needed by each process:\n");
for(i=0;i<n;i++)
{
for(j=0;j<m;j++)
{
scanf("%d",&max[i][j]);
}
}
printf("enter the allocated number of each typed
resource needed by each process:\n");
for(i=0;i<n;i++)
{
for(j=0;j<m;j++)
{
scanf("%d",&all[i][j]);
}
printf("Enter the available number of each type
of resource:\n");
for(j=0;j<m;j++)
```

```
{
scanf("%d",&ava[j]);
}
for(i=0;i<n;i++)
{
for(j=0;j<m;j++)
 {
  need[i][j]=max[i][j]-all[i][j];
 }
}
for(i=0;i<n;i++)
{
finish[i]=0;
}
while(flag)
{
 flag=0;
 for(i=0;i<n;i++)
 {
 c=0;
 for(j=0;j<m;j++)
 {
 if(finish[i]==0 && need[i][j]<=ava[j])
 {
  c++;
  if(c==m)
 {
  for(j=0;j<m;j++)
  {
   if(finish[i]==0 && need[i][j]<=ava[j])
   {
    c++;
```

3

```
{
 avail[j]+= alloc[i][j];
finish[i]=1;
flag=1;
}
if (finish[i]==1)
{
  i=n;
}
}
}
}
}
}

 j=0;
 flag=0;
 for (i=0;i<n;i++)
 {
  if(finish[i]==0)
 {
 dead[j]=i;
  j++;
 flag=1;
 }
}
if (flag==1)
{
Printf(" Dead lock has occured:\n");
printf ("The deadlock processes are:\n");
 for(i=0;i<n;i++)
 {
```

```
printf("P%d",dead[i]);
}
}
else
printf("No dead lock has occured!\n");
}
```

Output:

Enter the number of processes and number of types of resources:

5 3

Enter the maximum number of each type of resource needed by each process:

7 5 3

3 2 2

9 0 2

2 2 4

4 3 3

Enter the allocated number of each type of resources needed by each process:

0 1 0

2 0 0

3 0 2

2 1 1

0 0 2

Enter the available number of each type of

Deadlock has occurred.

3/4/24 LAB-9 program.

9) Write a program to simulate the following contiguous memory allocation techniques.

```
#include <stdio.h>
Struct Block
{
int block_no;
int block_size;
int is_free;
};
Struct File
int file_no;
int file_size;
};
void firstFit(struct Block blocks[], int n_blocks, struct File
files[], int n_files)
{
printf("Memory Management Scheme - First Fit\n");
printf("File_no\tFile_Size\tBlock_no\tBlock_size
\tFragment\n");
for(int i=0;i<n_files;i++)
{
for(int j=0;j<n_blocks;j++)
if (!blocks[j].is_free && blocks[j].block_size >=files[i]
file_size)
{
blocks[j].is_free=0;
printf("%d\t\t%d\t\t%d\t\t%d\t\t%d\n",
files[i].file_no,files[i].file_size,blocks[j].block_no,
blocks[j].block_size,blocks[j].block_size-files[i].file_size);
break;
}
}
```

```
void worstFit(struct Block blocks[], int n_blocks, struct File
files[], int n_files)
{
printf("Memory Management scheme - Worst Fit\n");
printf("File_no:\tFile_Size:\tBlock_no:\tBlock_size:\t
tFragment\n");
for(int i=0;i<n_files;i++)
{
int worst_fit_block = -1;
int max_fragment = -1;
for(int j=0;j<n_blocks;j++)
{
if(blocks[j].is_free && blocks[j].block_size >= files[i].file
size;
if(fragment>max_fragment)
{
max_fragment = fragment;
worst_fit_block = j;
}
}
}

if(worst_fit_block != -1)
{
blocks[worst_fit_block].is_free=0;
printf("%d\t\t%d\t\t%d\t\t%d\t\t%d\n",i+1,
files[i].file_size, blocks[worst_fit_block].block_no,
blocks[worst_fit_block].block_size, max_fragment);
}
}
```

```
void best_fit(struct block blocks[], int n_blocks,
struct file files[], int n_files)
{
printf("Memory management scheme - best fit\n");
printf("File_no:\tFile_size:\tBlock_no:\tBlock_size:
\tFragment\n");
for(int i=0;i<n_files;i++)
{
 int best_fit_block=-1;
int min_fragment=1000000;
for(int j=0;j<n_blocks;j++)
{
 if(blocks[j].is_free && blocks[j].block_size>=
files[i].file_size)
  {int fragment=blocks[j].block_size-files[i].file_size;
  if(fragment< min_fragment)
  {
   min_fragment=fragment;
   best_fit_block=j;
  }
  }
 }
if(best_fit_block!=-1)
{
blocks[best_fit_block].is_free=0;
printf("%d\t\t%d\t\t%d\t\t%d\n",
 files[i].file_no, files[i].file_size,blocks[best_fi
block].block_no,
blocks[best_fit_block].block_size,min_fragment);
}
}
```

```
int main()
{
int n_blocks, n_files;
printf("Enter the number of blocks:");
scanf("%d",&n_blocks);
printf("Enter the number of files:");
scanf("%d",&n_files);

struct Block blocks[n_blocks];
for(int i=0;i<n_blocks;i++)
{
blocks[i].block_no=i+1;
printf("Enter the size of block %d:",i+1);
scanf("%d",&blocks[i].block_size);
blocks[i].is_free=1;
}
struct file files[n_files];
for(int i=0;i<n_files;i++)
{
files[i].file_no=i+1;
printf("Enter the size of file %d:",i+1);
scanf("%d",&files[i].file_size);
}
printf("\n");

for(int i=0;i<n_blocks;i++)
{
printf("%d\t%d\t%d\n",
}
```

best fit(blocks, n-blocks, files, n-files);
return 0;
}

Output:

Enter the number of blocks: 3
Enter the number of files: 2
enter the size of block1: 5
Enter the size of block2: 2
Enter the size of block3: 7
Enter the size of file1: 1
Enter the size of file2: 4

Memory management scheme - First Fit.

| File No | File size | Block No | Block size | Fragment |
|---|---|---|---|---|
| 1 | 1 | 1 | 5 | 4 |
| 2 | 4 | 3 | 7 | 3 |

Memory management scheme - Worst Fit.

| File No | File size | Block No | Block size | Fragment |
|---|---|---|---|---|
| 1 | 1 | 3 | 7 | 6 |
| 2 | 4 | 1 | 5 | 1 |

Memory Management scheme - Best Fit.

| File No | File size | Block No | Block size | Fragment |
|---|---|---|---|---|
| 1 | 1 | 2 | 2 | 1 |
| 2 | 4 | 1 | 5 | 1 |

10/7/24

# LAB- 6 program

Write a c-Program to stimulate page replacement algorithms

a) FIFO

b) LRU

c) Optimal

```
#include <stdio.h>
#include <stdlib.h>
#include <limits.h>
void fifo(int pages[], int n, int capacity)
{
  int frame[capacity], index=0, page_faults=0;
for(int i=0; i<capacity; i++)
  frame[i] = -1;
for(int i=0; i<n; i++)
{
  int found = 0;
for(int j
```

```
void print_frames(int frame[], int capacity, int page_faults)
{
{
for(int i=0; i< capacity; i++)
{
if(frame[i]==-1)
printf("-");
else
printf("%d", frame[i]);
}
if(page_faults>0)
```

```
printf("PF No. %d", page_faults);
printf("\n");
}
void fifo(int pages[], int n, int capacity)
{
int frame[capacity], index=0, page_faults=0;
for (int i=0; i<capacity; i++)
frame[i]=-1;
printf("FIFO page Replacement Process:\n");
for (int i=0; i<n; i++)
{
int found=0;
for (int j=0; j<capacity; j++)
{
if (frame[j]==pages[i])
{
found=1;
break;
}
}
if (!found)
{
frame[index]=pages[i];
index=(index+1)%capacity;
page_faults++;
}
page_frames[frame, capacity, found ?0 : page_faults
}
printf("Total page faults using FIFO: %d\n",
page_faults
}
```

```
printf("Total page faults using FIFO: %d\n", page_faults);
}
void lru(int pages[], int n, int capacity)
{
 int frame[capacity], counter[capacity], time=0;
page_faults=0;
 for(int i=0;i<capacity;i++)
{
  frame[i]=-1;
  counter[i]=0;
 }
printf("LRU Page Replacement Process:\n");
 for(int i=0;i<n;i++)
   {
  int found=0;
  for(int j=0;j<capacity;j++)
   {
    if(frame[j]==pages[i])
   {
    found=1;
    counter[j]=time++;
     break;
   }
  }
 if(!found)
 {
  int min=INT_MAX, min_index=-1;
 for(int j=0;j<capacity;j++)
 {
  if(counter[j]<min)
```

```
{
  min = counter[j];
  min_index = j;
}
}
frame[min_index] = pages[i];
counter[min_index] = time++;
page_faults++;
}
print_frames(frame, capacity, found ? 0 : page_faults);
}
printf("Total page faults using LRU: %d\n", page_faults);
}

void optimal(int page[], int n, int capacity)
{
int frame[capacity], page_faults = 0;
for(int i=0; i<capacity; i++)
frame[i] = -1;
printf("\nOptimal page Replacement process:\n");
for(int i=0; i<n; i++)
  {
  int found = 0;
  for(int j=0; j<capacity; j++)
  {
  if (frame[j] == page[i])
  {
  found = 1;
  break;
  }
  }
```

```
if (!found)
{
 int farthest=i+1, index = -1;
 for(int j=0; j< capacity ;j++)
 {
  int k;
 for(k = i+1 ; k<n ; k++)
    {
     if (frame[j]==pages[k])
      break;
    }
  if (k > farthest)
  {
   farthest = k;
   index = j;
  }
 }
if(index == -1)
{
for(int j=0 ; j<capacity ; j++)
{
  if (frame[j]==-1)
  {
   index =j;
   break;
  }
 }
}
frame[index]=pages[i];
 page_fault++;
}
```

```
print_frames(frame, capacity, found ? 0 : page_fault);
}
printf("Total page faults using optimal: %d\n", page_fault);
}
int main()
{
int n, capacity;
printf("Enter the number of pages:");
scanf("%d", &n);
int *pages = (int*) malloc(n*sizeof(int));
printf("Enter the pages:");
for(int i=0; i<n; i++)
scanf("%d", &pages[i]);
printf("Enter the frame capacity:");
scanf("%d", &capacity);
printf("\n pages:");
for(int i=0; i<n; i++)
printf("%d", pages[i]);
printf("\n\n");
fifo(pages, n, capacity);
lru(pages, n, capacity);
optimal(pages, n, capacity);
free(pages);
return 0;
}
```

output:

Enter the number of pages: 20

Enter the pages : 7 0 1 2 0 3 0 4 2 3 0 3 2 1 2 0 7 0 1

Enter the frame capacity: 3

pages : 7 0 1 2 0 3 0 4 2 3 0 3 2 1 2 0 1 7 0 1

FIFO Page Replacement process:

7 - - PF NO. 1

7 0 - PF NO. 2

7 0 1 PF NO. 3

2 0 1 PF NO. 4

2 0 1

2 3 1 PF NO. 5

2 3 0 PF NO. 6

4 3 0 PF NO. 7

4 2 0 PF NO. 8

4 2 3 PF NO. 9

0 2 3 PF NO. 10

0 2 3

0 2 3

0 1 3 PF NO. 11

0 1 2 PF NO. 12

0 1 2

0 1 2

7 1 2 PF NO. 13

7 0 2 PF NO. 14

7 0 1 PF NO. 15

Total page faults using FIFO : 15

LRU Page Replacement process:

7 - PF NO. 1

0 - PF NO. 2

1 - PF NO. 3

0 1 2 PF NO. 4

0 1 2

0 3 2 PF NO. 5

0 3 2

0 3 4 PF NO. 6

0 2 4 PF NO. 7

3 2 4 PF NO. 8

3 2 0 PF NO. 9

3 2 0

3 2 1 PF NO. 10

3 2 1

0 2 1 PF NO. 11

0 2 1

0 7 1 PF NO. 12

0 7 1

0 7 1

Total page faults using LRU: 12.

optimal Page Replacement process:

7 _ _ PF No. 1
7 0 _ PF No. 2
7 0 1 PF No. 3
2 0 1 PF No. 4
2 0 1
2 0 3 PF No. 5
2 0 3
2 4 3 PF No. 6
2 4 3
2 4 3
2 0 3 PF No. 7
2 0 3
2 0 3
2 0 1 PF No. 8
2 0 1
2 0 1
2 0 1
7 0 1 PF No. 9
7 0 1
7 0 1

Total page fault using optimal: 9