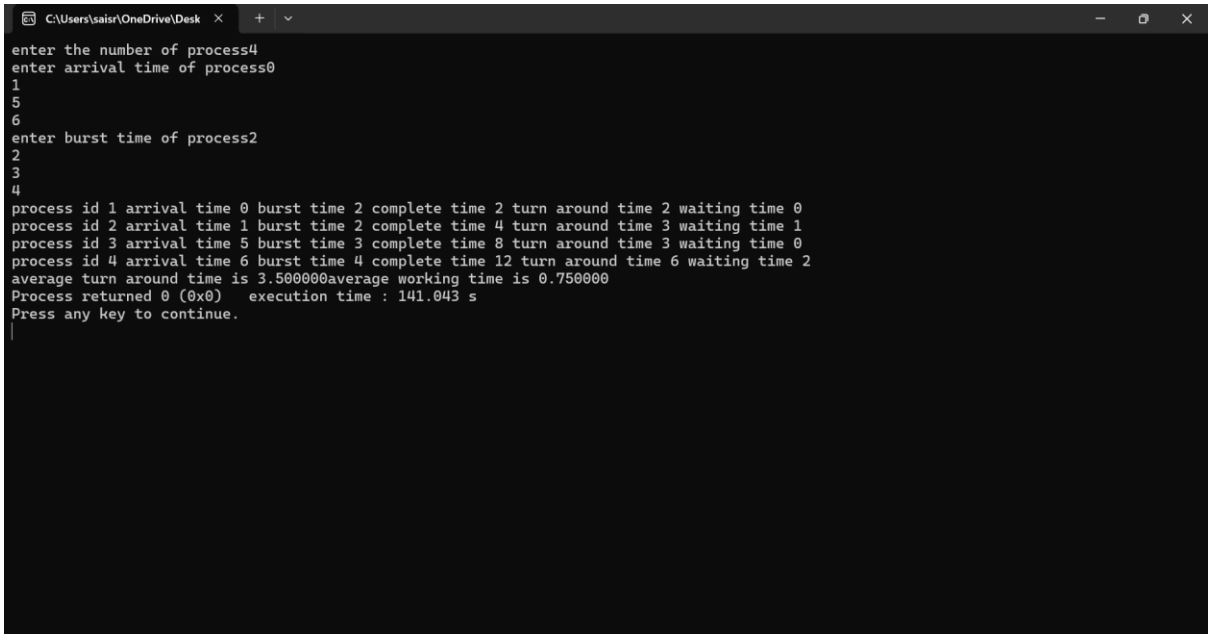
1.

a.FCFS scheduling using array

```
#include<stdio.h>
int main(){
   int n,i;
   float atat=0,awt=0;
   printf("enter the number of process");
   scanf("%d",&n);
   int atime1[n],btime2[n],ctime3[n],tattime4[n],wtime5[n];
   printf("enter arrival time of process");
   for(i=0;i<n;i++){
      scanf("%d",&atime1[i]);
   }
   printf("enter burst time of process");
   for(i=0;i<n;i++){
      scanf("%d",&btime2[i]);
   }
   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]=tattime4[i]-btime2[i];
  }
  for(i=0;i<n;i++){
    atat=atat+tattime4[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",i+1,atime1[i],btime2[i],ctime3[i],tattime4[i],wtime5[i]);
  }
  printf("average turn around time is %f",atat);
  printf("average working time is %f",awt);
}
```

output:



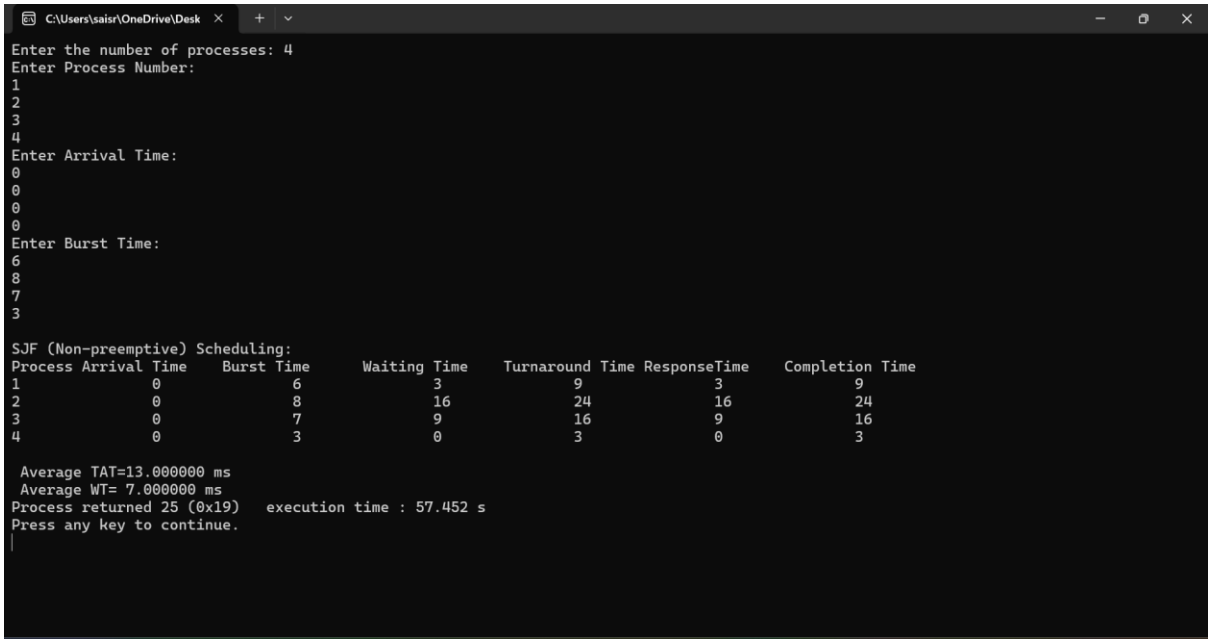
b.SJF(non-preemptive)scheduling using array

```
#include<stdio.h>
 void findCompletionTime(int processes[], int n, int bt[], int at[], int wt[], int tat[], int rt[], int ct[])
 {
 int completion[n];
 int remaining[n];
 for (int i = 0; i < n; i++)
 remaining[i] = bt[i];
 int currentTime = 0;
 for (int i = 0; i < n; i++)
 {
 int shortest =-1;
 for (int j = 0; j < n; j++)
 {
 if (at[j] <= currentTime && remaining[j] > 0)
 {
 if (shortest ==-1 || remaining[j] < remaining[shortest])
 shortest = j;
 }
 }
```

```
 if (shortest ==-1)
 {
 currentTime++;
 continue;
 }
 completion[shortest] = currentTime + remaining[shortest];
 currentTime = completion[shortest];
 wt[shortest] = currentTime- bt[shortest]- at[shortest];
 tat[shortest] = currentTime- at[shortest];
 rt[shortest] = wt[shortest];
 remaining[shortest] = 0;
 }
 printf("Process\tArrival Time\tBurst Time\tWaiting Time\tTurnaround
Time\tResponseTime\tCompletion Time\n");
 for (int i = 0; i < n; i++)
 {
 ct[i] = completion[i];
 printf("%d\t\t%d\t\t%d\t\t%d\t\t%d\t\t%d\t\t%d\n", processes[i], at[i], bt[i], wt[i], tat[i], rt[i], ct[i]);
 }
 float avg_tat=tat[0];
 for(int i=1;i<n;i++)
 {
avg_tat+=tat[i];
 }
 printf("\n Average TAT=%f ms",avg_tat/n);
 float avg_wt=wt[0];
 for(int i=1;i<n;i++)
 {
 avg_wt+=wt[i];
 }
 printf("\n Average WT= %f ms",avg_wt/n);
```

```
}
void main()
{
int n;
printf("Enter the number of processes: ");
scanf("%d", &n);
int processes[n];
int burst_time[n];
int arrival_time[n];
printf("Enter Process Number:\n");
for (int i = 0; i < n; i++)
{
scanf("%d", & processes[i]);
}
printf("Enter Arrival Time:\n");
for (int i = 0; i < n; i++)
{
scanf("%d", &arrival_time[i]);
}
printf("Enter Burst Time:\n");
for (int i = 0; i < n; i++)
{
scanf("%d", &burst_time[i]);
}
int wt[n], tat[n], rt[n], ct[n];
for (int i = 0; i < n; i++)
rt[i] =-1;
printf("\nSJF (Non-preemptive) Scheduling:\n");
findCompletionTime(processes, n, burst_time, arrival_time, wt, tat, rt, ct);
}
```

output:



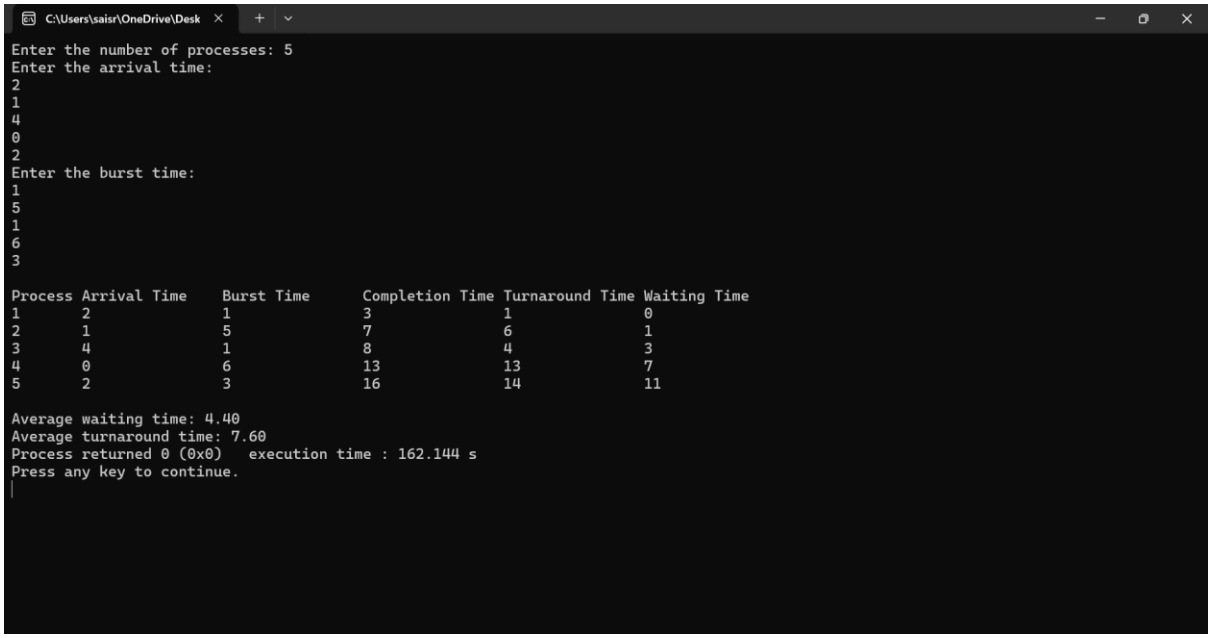
c.SJF(preemptive)scheduling using array

```
#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++;
        }
    }
    if (available_count == 0) {
        current_time++;
        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("\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;
    printf("Enter the number of processes: ");
    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");
    for (int i = 0; i < n; i++) {
        scanf("%d", &bt[i]);
    }
    sjf_preemptive(n, at, bt);
    return 0;
}
```

output:



2.

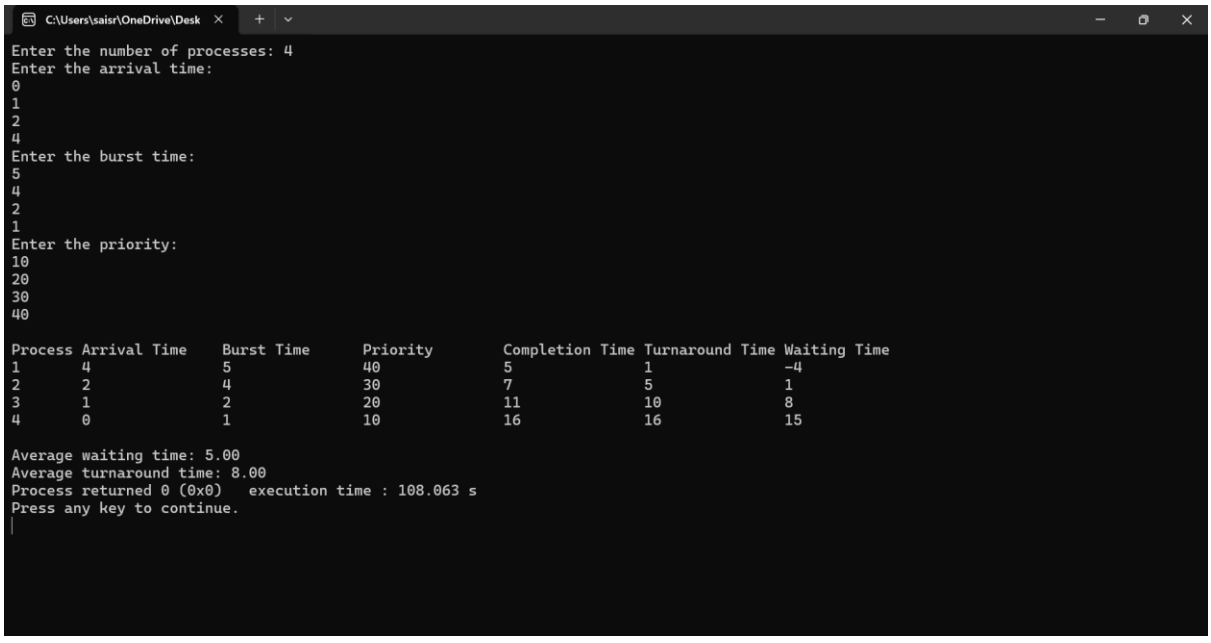
a.priority(non preemptive)scheduling

```
#include<stdio.h>

#define MAX 10

void priority_non_preemptive(int n, int at[], int bt[], int p[]) {
   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];
   }
   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[0];
    for (int i = 1; i < n; i++) {
        ct[i] = ct[i - 1] + bt[i];
        tat[i] = ct[i] - at[i];
        wt[i] = tat[i] - bt_copy[i];
        total_wt += wt[i];
        total_tat += tat[i];
    }
    printf("\nProcess\tArrival Time\tBurst Time\tPriority\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\t\t%d\n", i+1, at[i], bt_copy[i], p[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;
```

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

output:



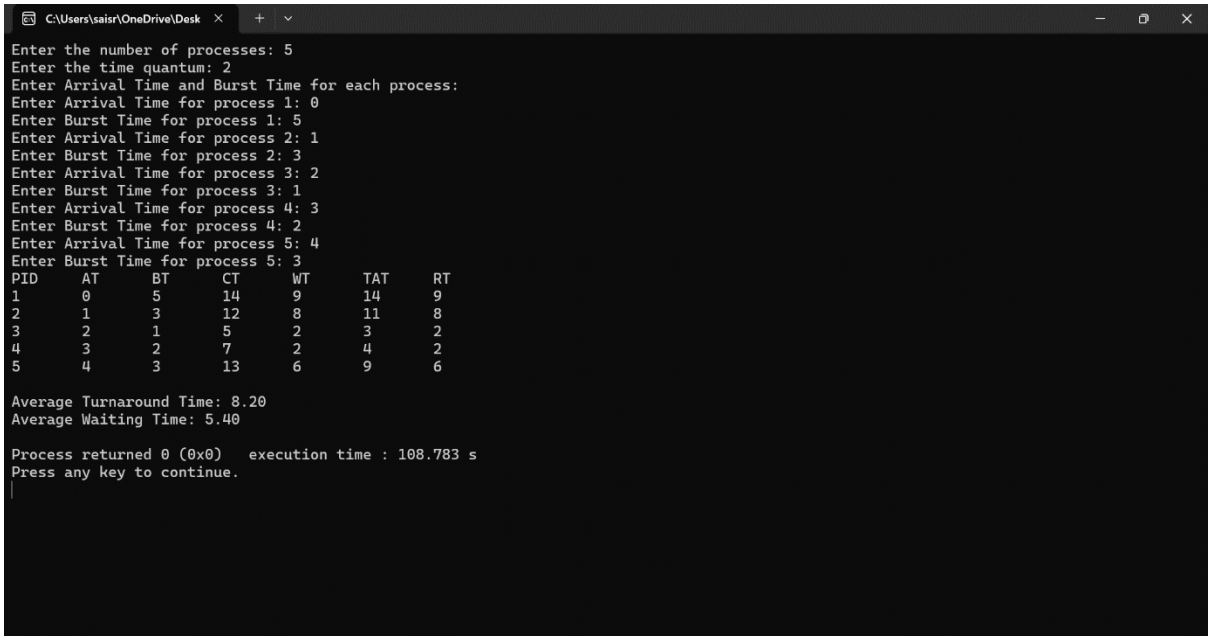
b.Round robin scheduling

```
#include <stdio.h>
 struct Process {
 int pid;
 int burst_time;
 int arrival_time;
 int remaining_time;
 };
 void roundRobin(struct Process processes[], int n, int time_quantum) {
 int remaining_processes = n;
 int current_time = 0;
 int completed[n];
 int ct[n], wt[n], tat[n], rt[n];
 for (int i = 0; i < n; i++) {
 completed[i] = 0;
 }
 while (remaining_processes > 0) {
 for (int i = 0; i < n; i++) {
 if (completed[i] == 0 && processes[i].arrival_time <= current_time) {
 if (processes[i].remaining_time > 0) {
 if (processes[i].remaining_time <= time_quantum) {
 current_time += processes[i].remaining_time;
 processes[i].remaining_time = 0;
 completed[i] = 1;
 remaining_processes--;
 ct[i] = current_time;
 tat[i] = ct[i]- processes[i].arrival_time;
 } else {
 current_time += time_quantum;
 processes[i].remaining_time-= time_quantum;
 }
 wt[i] = ct[i]- processes[i].arrival_time- processes[i].burst_time;
```

```
rt[i] = wt[i];
}
}
}
}
printf("PID\tAT\tBT\tCT\tWT\tTAT\tRT\n");
float avg_tat = 0, avg_wt = 0;
for (int i = 0; i < n; i++) {
printf("%d\t%d\t%d\t%d\t%d\t%d\t%d\n", processes[i].pid, processes[i].arrival_time,
processes[i].burst_time, ct[i], wt[i], tat[i], rt[i]);
avg_tat += tat[i];
avg_wt += wt[i];
}
avg_tat /= n;
avg_wt /= n;
printf("\nAverage Turnaround Time: %.2f\n", avg_tat);
printf("Average Waiting Time: %.2f\n", avg_wt);
}
int main() {
int n, time_quantum;
printf("Enter the number of processes: ");
scanf("%d", &n);
printf("Enter the time quantum: ");
scanf("%d", &time_quantum);
struct Process processes[n];
printf("Enter Arrival Time and Burst Time for each process:\n");
for (int i = 0; i < n; i++) {
printf("Enter Arrival Time for process %d: ", i+1);
scanf("%d", & processes[i].arrival_time);
printf("Enter Burst Time for process %d: ", i+1);
scanf("%d", & processes[i].burst_time);
```

```
 processes[i].pid = i+1;
 processes[i].remaining_time = processes[i].burst_time;
 }
 roundRobin(processes, n, time_quantum);
 }
```

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.

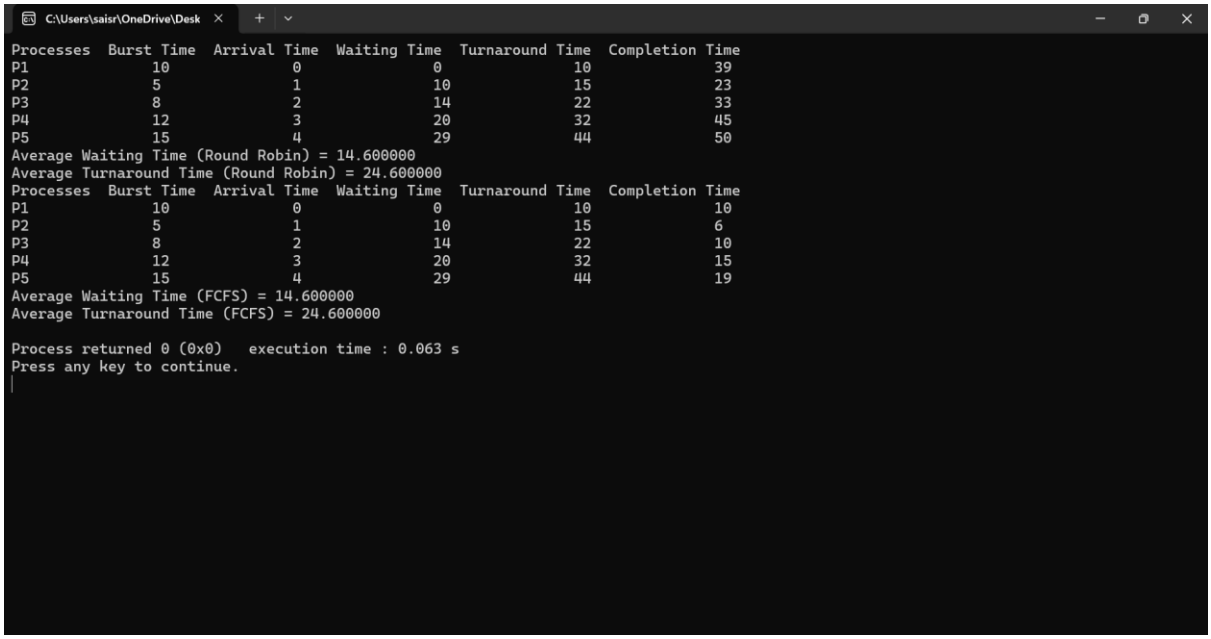
```
#include <stdio.h>
// Function to find waiting time for FCFS
void findWaitingTime(int processes[], int n, int bt[], int at[], int wt[]) {
   wt[0] = 0;
   for (int i = 1; i < n; i++) {
      wt[i] = bt[i-1] + wt[i-1] - at[i-1];
      if (wt[i] < 0)
         wt[i] = 0;
   }
}
// Function to find turnaround time
```

```
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];
    }
}
// Function to implement Round Robin scheduling
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);
}
// Function to implement FCFS scheduling
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:



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

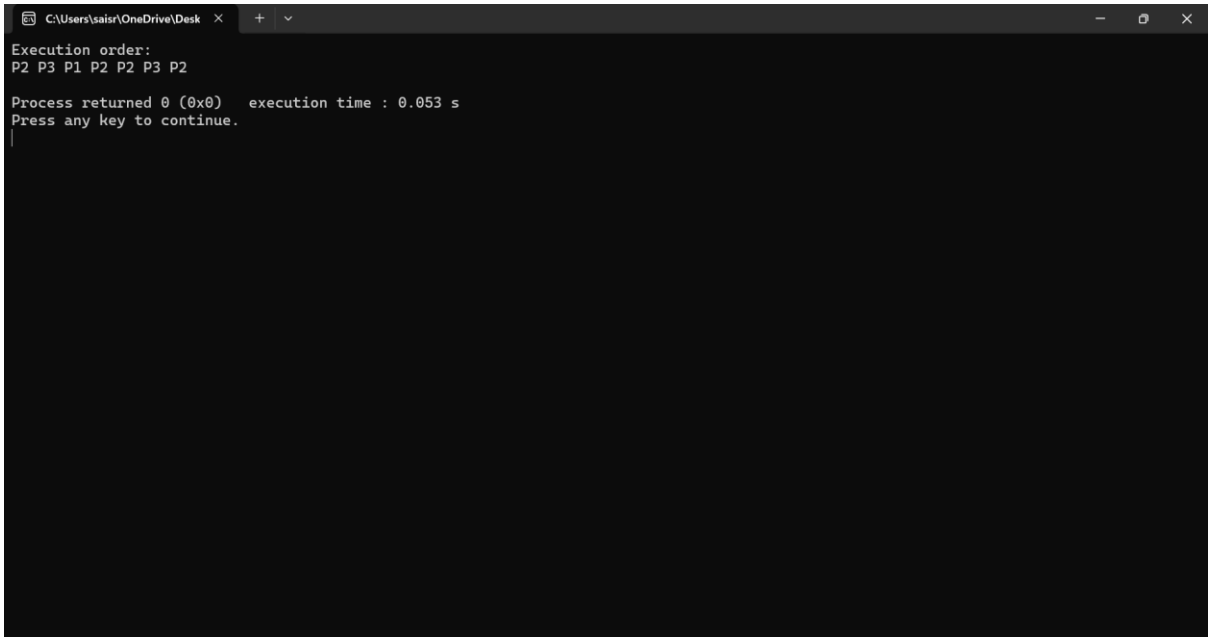
a) Rate- Monotonic

```
#include <stdio.h>
// Structure to represent a process
struct Process {
int execution_time;
int time_period;
};
// Function to calculate the least common multiple (LCM)
int lcm(int a, int b) {
int max = (a > b) ? a : b;
while (1) {
if (max % a == 0 && max % b == 0)
return max;
max++;
}
```

```
}
// Function to check if the set of processes is schedulable
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}, // P1
        {2, 5},  // P2
        {2, 10}  // P3
    };
    int n = sizeof(processes) / sizeof(processes[0]);

    // Check if the processes are schedulable
    if (!is_schedulable(processes, n)) {
        printf("The given set of processes is not schedulable.\n");
        return 0;
    }
    // Calculate the scheduling time (LCM of time periods)
    int scheduling_time = lcm(processes[0].time_period, processes[1].time_period);
    scheduling_time = lcm(scheduling_time, processes[2].time_period);
    // Display the execution order
    printf("Execution order:\n");
    for (int t = 0; t < scheduling_time; t++) {
        if (t % processes[1].time_period == 0)
            printf("P2 ");
        if (t % processes[2].time_period == 0)
```

```
printf("P3 ");
if (t % processes[0].time_period == 0)
printf("P1 ");
}
printf("\n");
return 0;
}
```

output:



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++)
                        {
```

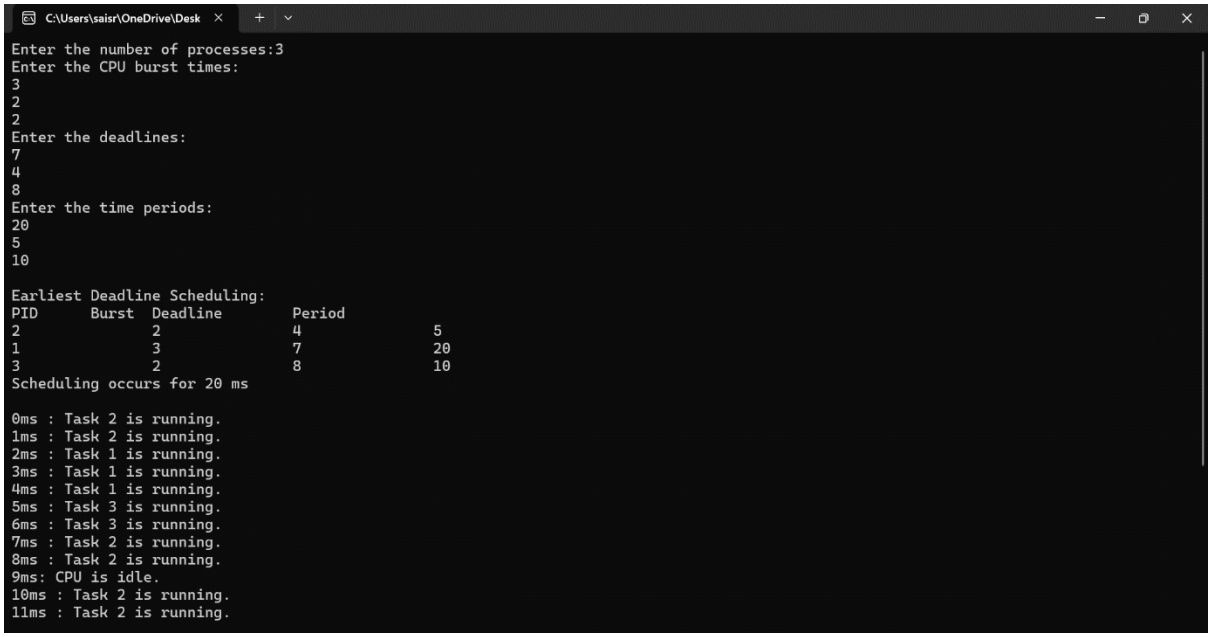
```
                    if (d[j] < d[i])
                        {
                          temp = d[j];
                          d[j] = d[i];
                          d[i] = temp;
                          temp = pt[i];
                          pt[i] = pt[j];
                          pt[j] = temp;
                          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)
{
```

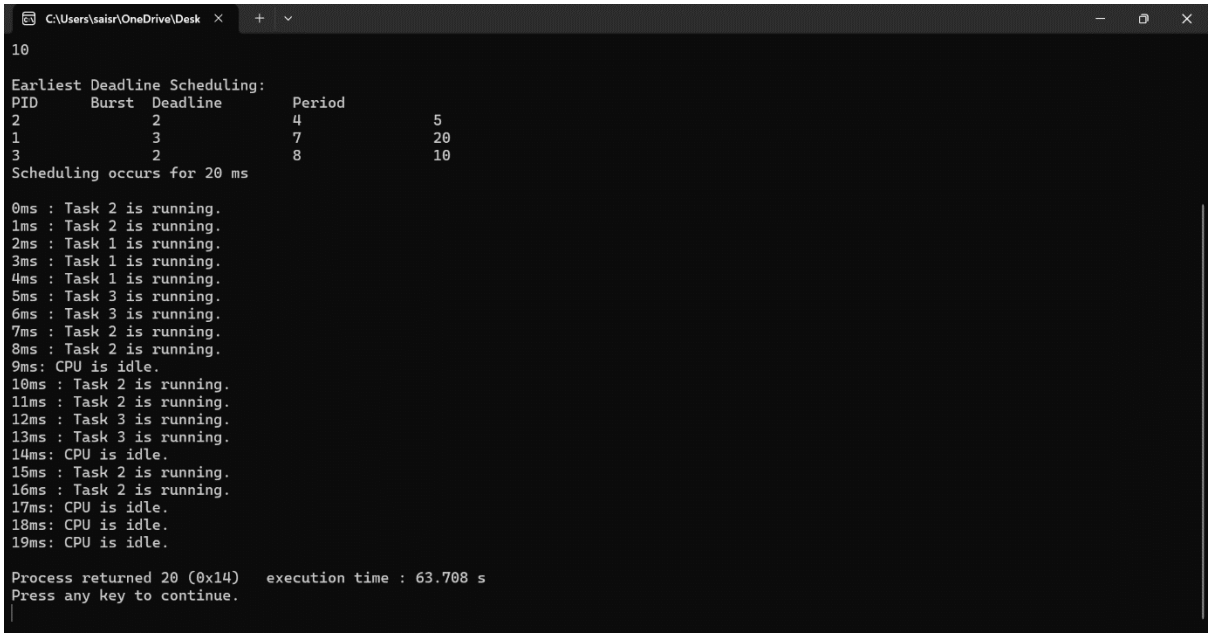
```
  int lcm = p[0];
  for (int i = 1; i < n; i++)
            {
              lcm = (lcm * p[i]) / gcd (lcm, p[i]);
            }
  return lcm;
}


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);
```

```
//LCM
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);
//EDF
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:



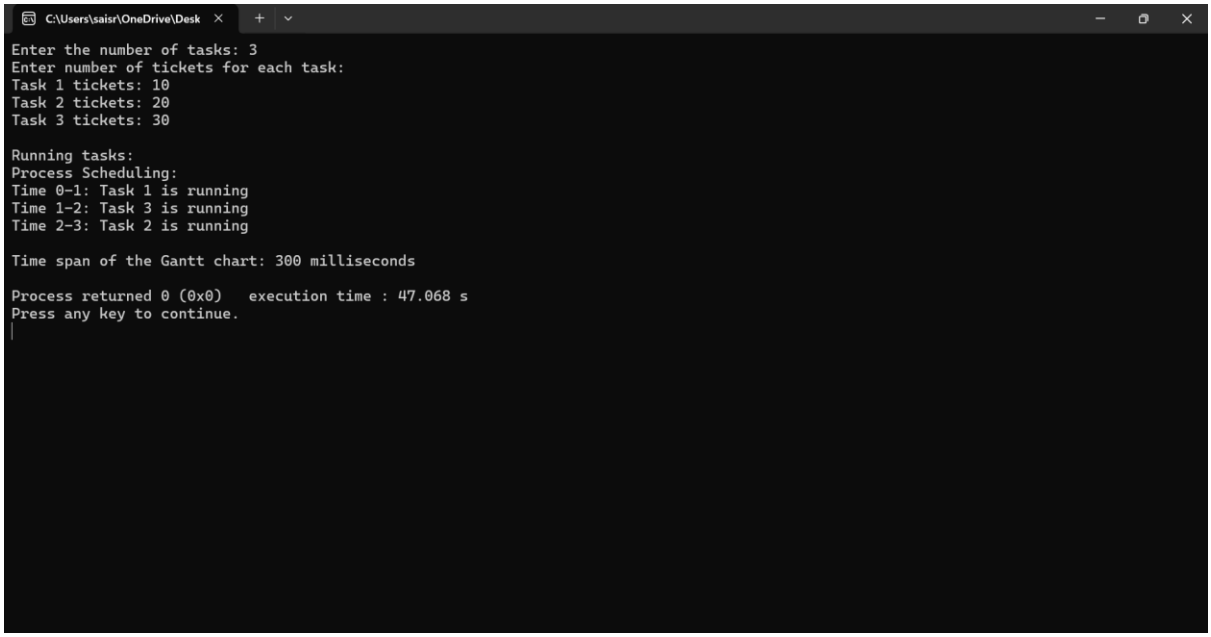


c) Proportional scheduling

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

#define MAX_TASKS 10
#define MAX_TICKETS 100
#define TIME_UNIT_DURATION_MS 100 // Duration of each time unit in milliseconds

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++;
    }

    // Calculate time span in milliseconds
    *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:

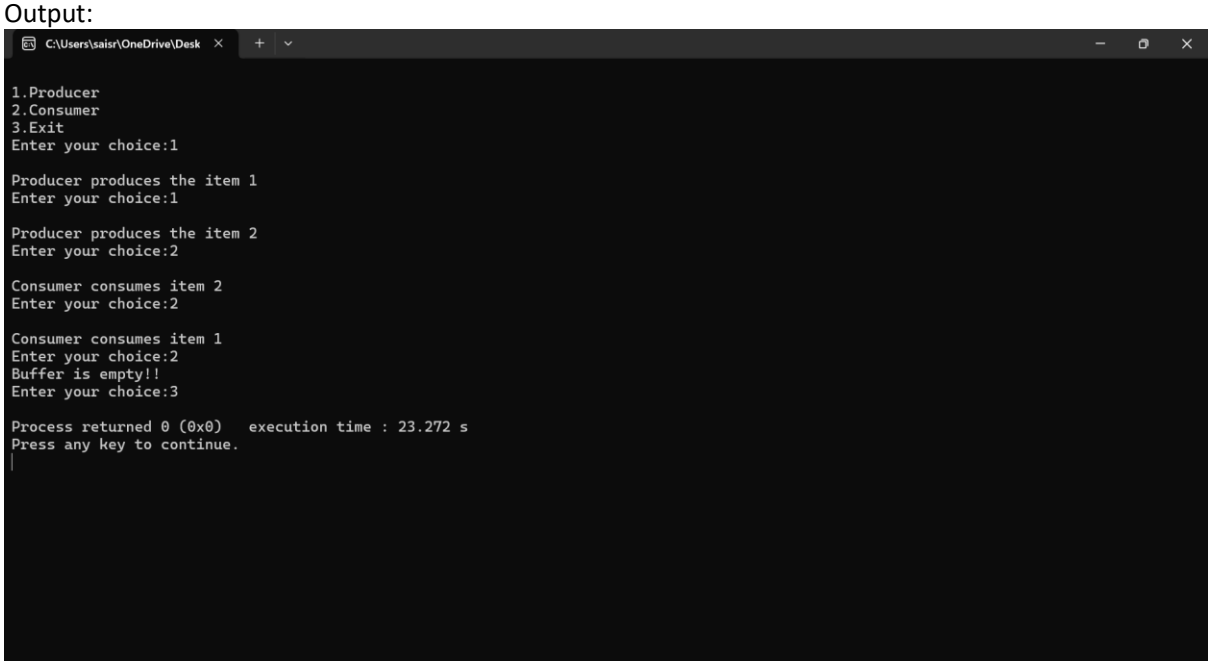


5. Write a C program to simulate producer-consumer problem using semaphores.

```
#include <stdio.h>
#include <stdlib.h>
#include <pthread.h>
#include <semaphore.h>

#define BUFFER_SIZE 5
#define MAX_ITEMS 20

int buffer[BUFFER_SIZE];
int in = 0;
int out = 0;
int produced_count = 0;
int consumed_count = 0;
sem_t mutex;
sem_t full;
sem_t empty;

void* producer(void* arg) {
   int item = 1;
   while (produced_count < MAX_ITEMS) {
      sem_wait(&empty);
      sem_wait(&mutex);
      buffer[in] = item;
      printf("Produced: %d\n", item);
      item++;
      in = (in + 1) % BUFFER_SIZE;
      produced_count++;
      sem_post(&mutex);
      sem_post(&full);
   }
   pthread_exit(NULL);
}

void* consumer(void* arg) {
   while (consumed_count < MAX_ITEMS) {
```

```
        sem_wait(&full);
        sem_wait(&mutex);
        int item = buffer[out];
        printf("Consumed: %d\n", item);
        out = (out + 1) % BUFFER_SIZE;
        consumed_count++;
        sem_post(&mutex);
        sem_post(&empty);
    }
    pthread_exit(NULL);
}

int main() {
    pthread_t producerThread, consumerThread;
    sem_init(&mutex, 0, 1);
    sem_init(&full, 0, 0);
    sem_init(&empty, 0, BUFFER_SIZE);

    pthread_create(&producerThread, NULL, producer, NULL);
    pthread_create(&consumerThread, NULL, consumer, NULL);

    pthread_join(producerThread, NULL);
    pthread_join(consumerThread, NULL);

    sem_destroy(&mutex);
    sem_destroy(&full);
    sem_destroy(&empty);

    return 0;
}
```

Output:



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

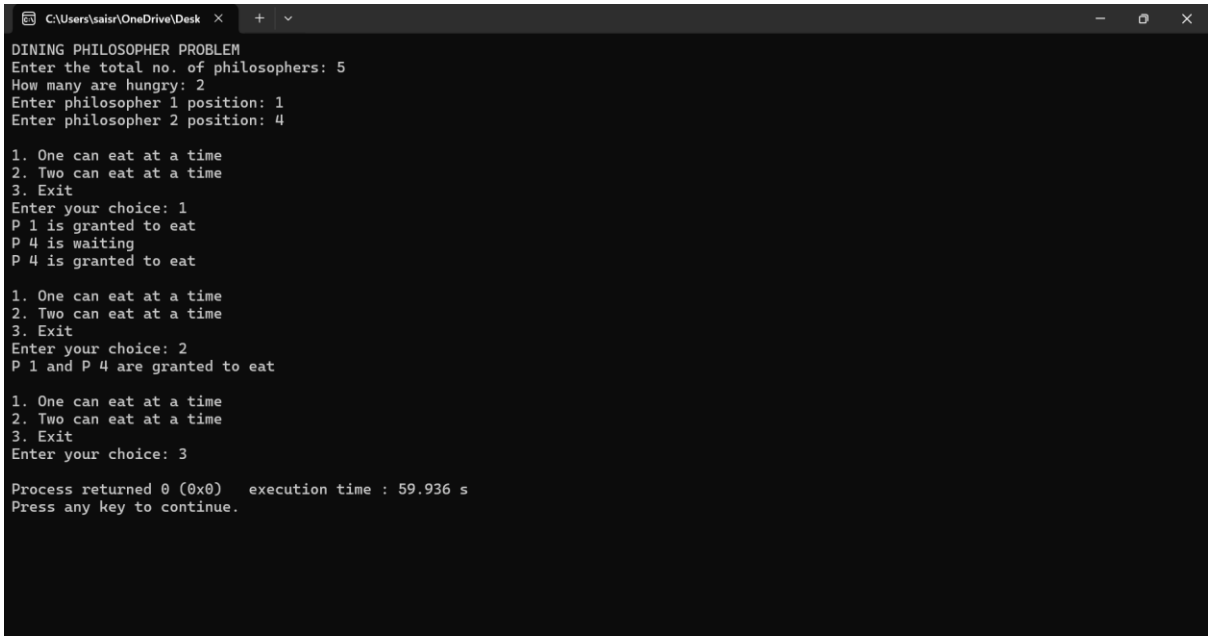
```
#include <stdio.h>

#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.

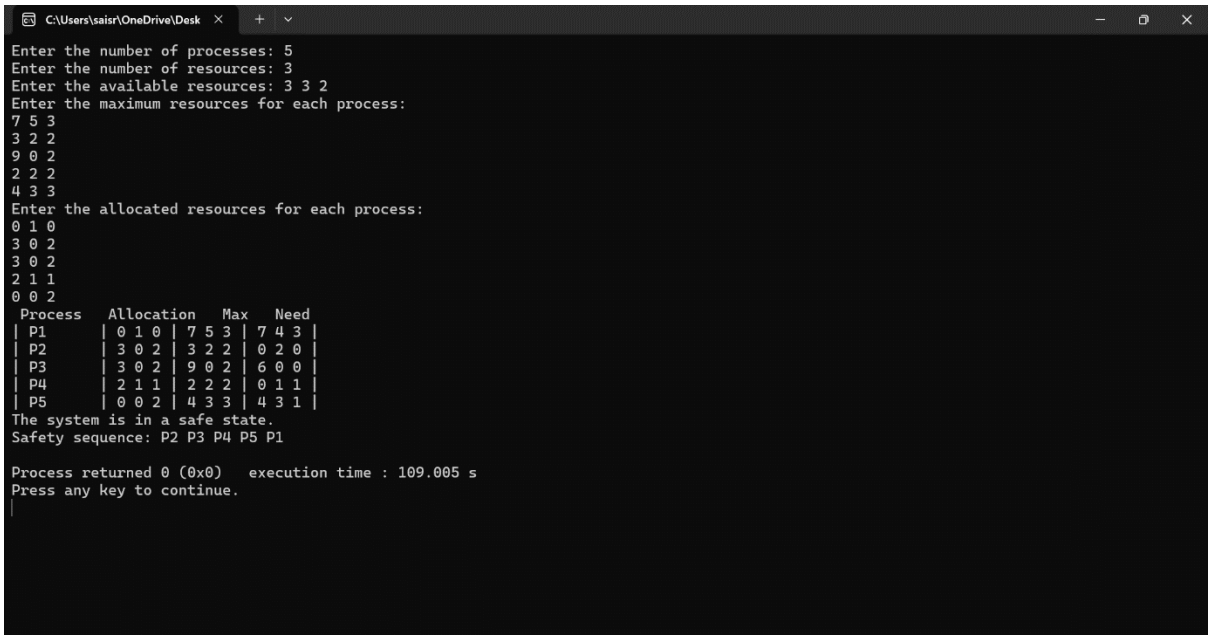
```
#include <stdio.h>

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:



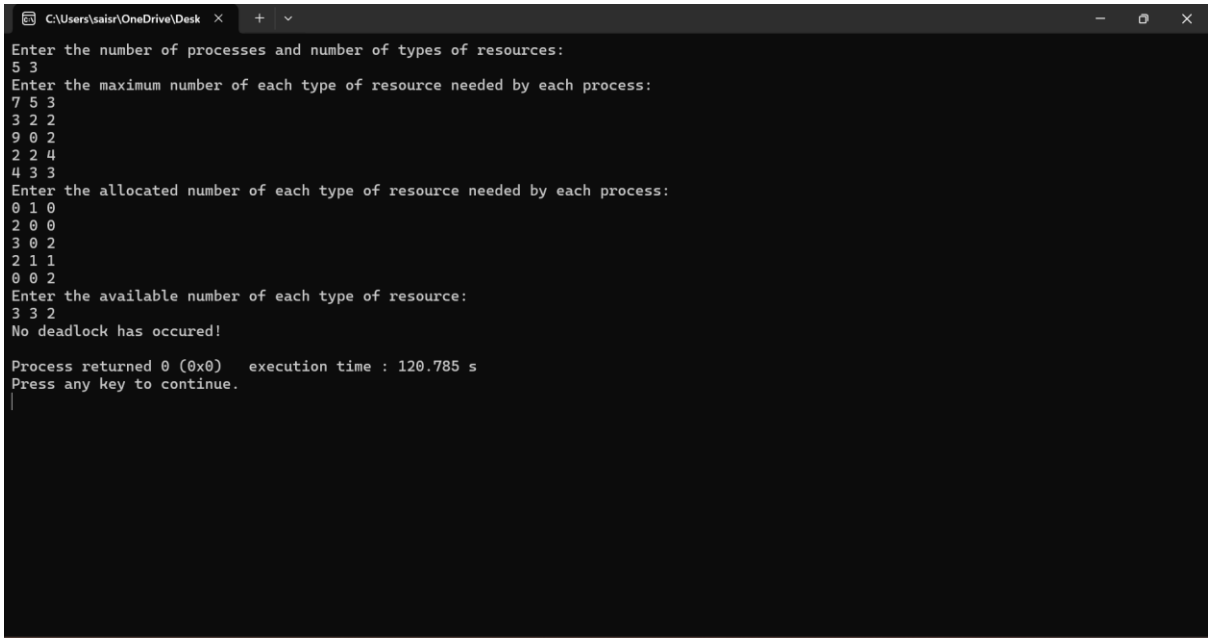
8. Write a C program to simulate deadlock detection

```
#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

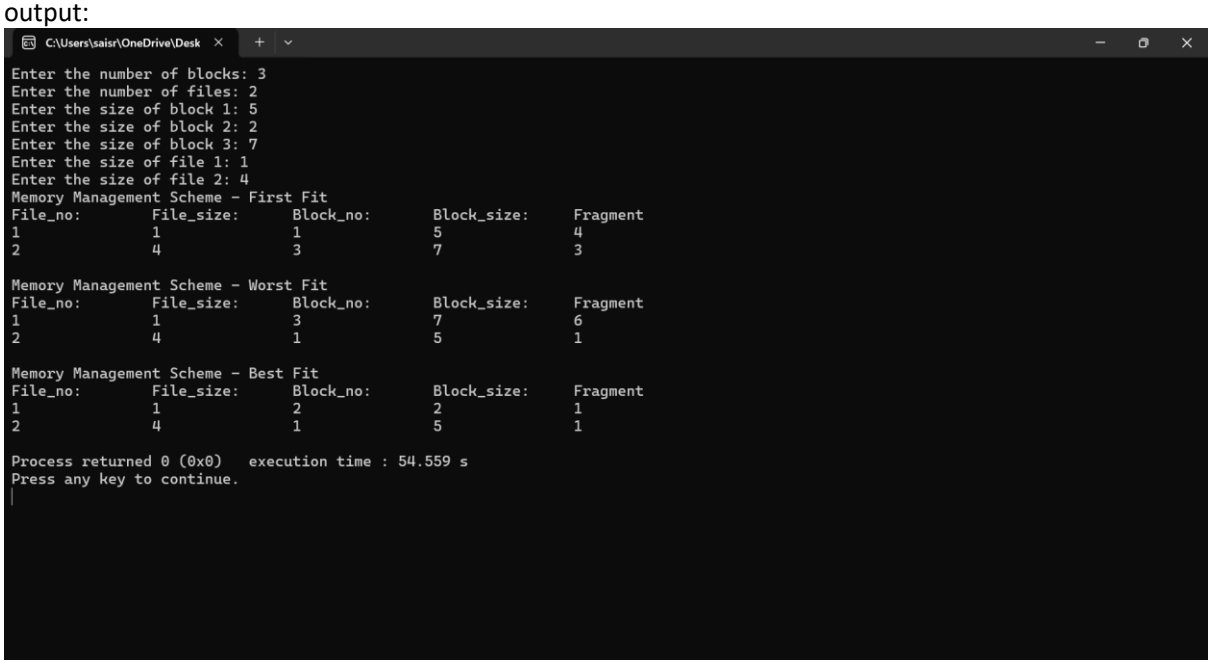
c) First-fit

```
#include <stdio.h>

struct Block {
   int block_no;
   int block_size;
   int is_free; // 1 for free, 0 for allocated
};

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; // Initialize with a negative value
      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; // Initialize with a large value
        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");
```

```
    // Reset blocks for worst fit
    for (int i = 0; i < n_blocks; i++) {
        blocks[i].is_free = 1;
    }

    worstFit(blocks, n_blocks, files, n_files);
    printf("\n");

// Reset blocks for best fit
    for (int i = 0; i < n_blocks; i++) {
        blocks[i].is_free = 1;
    }

    bestFit(blocks, n_blocks, files, n_files);

    return 0;
}
```

output:



10. Write a C program to simulate paging technique of memory management.

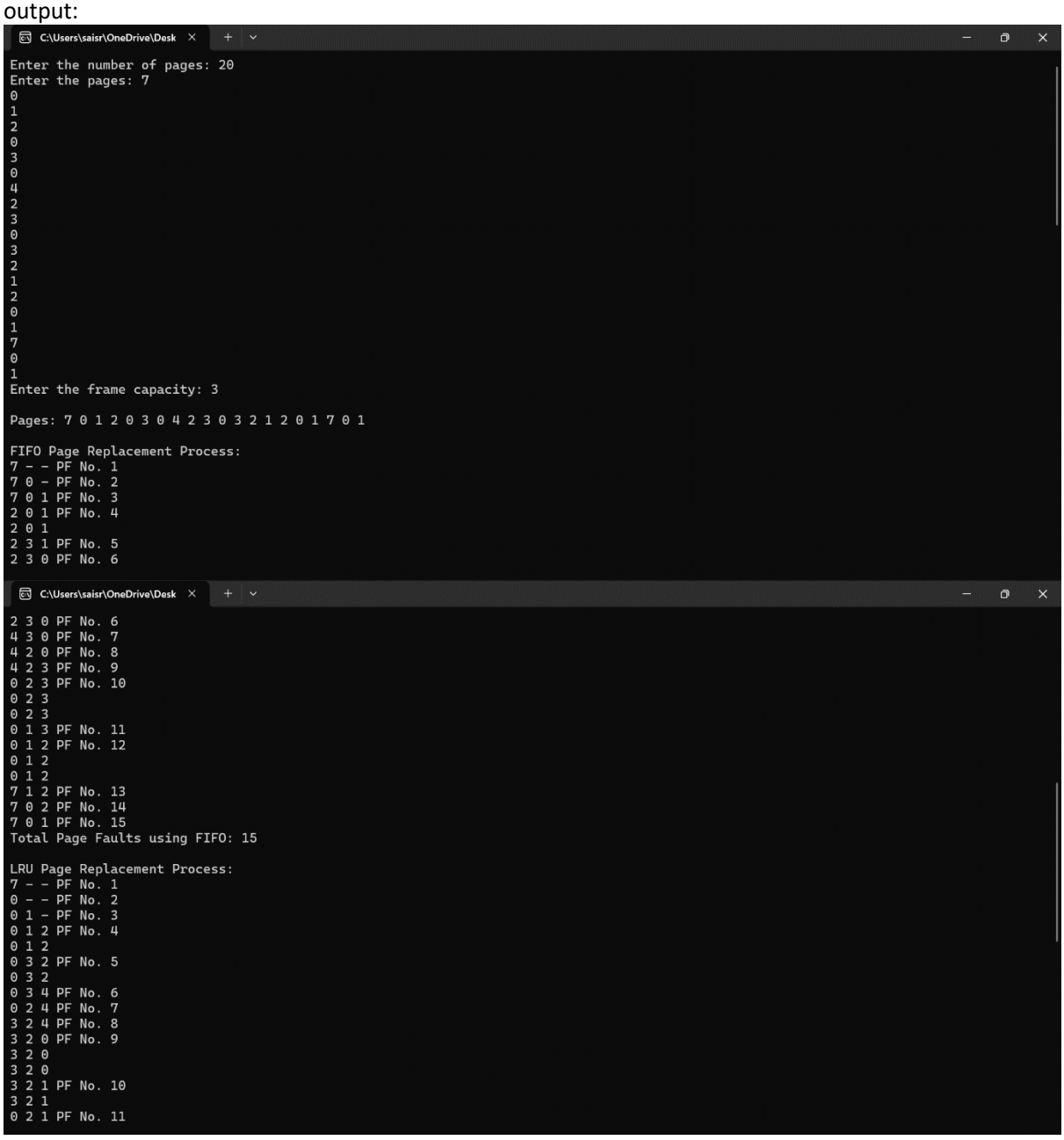
```
#include <stdio.h>
#include <limits.h>
#include <stdlib.h>

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");
}
```

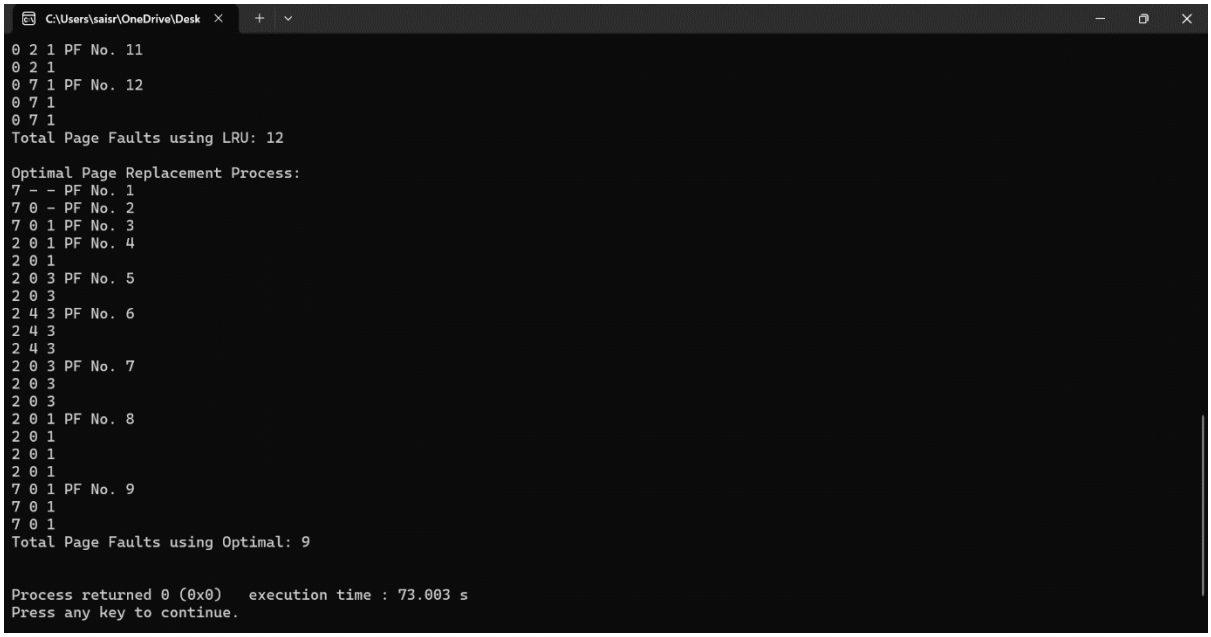
```
void fifo(int pages[], int n, int capacity) {
   int frame[capacity], index = 0, page_faults = 0;
   for (int i = 0; i < capacity; i++)
      frame[i] = -1;

   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.

~~Scheduling Programming~~

Scheduling Programming

Lab-1 8/5/24

(1) write a c program to simulate the following non preemptive cpu scheduling ~~algorithms~~ algorithm & find turn around time and waiting time
i) fcfs

```
#include<stdio.h>
int main(){
    int n,i;
    float atat=0, awt=0;
    printf("enter the number of process");
    scanf("%d",&n);
    int atime1[n], btime2[n], ctime3[n], tattime4[n], wtime5[n];
    printf("enter arrival time of process");
    for(i=0; i<n; i++){
        scanf("%d", &atime1[i]);
    }
    printf("enter burst time of process");
    for(i=0; i<n; i++){
        scanf("%d",&btime2[i]);
    }
    for(i=0; i<n; i++){
        if(i==0){
            ctime3[i] = atime1[i] + btime2[i];
        }
        else{
            ~~if(ctime3[i-1])~~
            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++){
    wtimes[i] = tattime4[i] - btime2[i];
}
for(i=0; i<n; i++){
    atat = atat + tattime4[i];
}
atat = (atat/n);
for(i=0; i<n; i++){
    awt = awt + wtimes[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", i+1,
        atime1[i], btime2[i], ctime3[i], tattime4[i], wtimes[i]);
}
printf("average turn around time is %f ", atat);
printf("average working time is %f ", awt);
}
```

output:

```
enter the number of process4
enter arrival time of process 0
1
5
6
enter burst time of process 2
2
3
4
process id 1 arrival time 0 burst time 2 complete time 2 turn around time 2
waiting time 0
process id 2 arrival time 1 burst time 2 complete time 4 turn around time 3
waiting time 1
Process id 3 arrival time 5 burst time 3 complete time 8 turn around time 3
waiting time 0
process id 4 arrival time 6 burst time 4 complete time 12 turn around time 6
waiting time 2
average tu
1
```

average turn around time

~~SJF (shortest job first)~~
~~non preemptive~~
(b) SJF (Shortest Job First)
non preemptive

```
#include<stdio.h>
int main(){
  int n,i,j,temp1,temp2;
  float atat=0, awt=0;
  printf(" enter the numb
  scanf("%d", &n);
  int atime1[n], btime2
  printf(" enter proces
  for(i=0; i<n; i++){
    scanf("%d", &Pid
  }
  printf("enter arrival
  for(i=0; i<n; i++){
    scanf("%d", &at
  }
  printf(" enter burst
  for(i=0; i<n; i++){
    scanf("%d", &b
  }
  for(i=0; i<n-1; i++)
    for(j=0; j<n-i-1;
      if(btime2[j]>
        temp1 = bt
        btime2[j]
        btime2[j+
        temp2 = P
        Pid[j] =
        Pid[j+1]
      }
  }
}
```

average turn around time is 3.500000 average waiting time is 0.750000

~~sjf (shortest job first)~~
~~non preemptive~~

(b) sjf (shortest job first)
non preemptive

```
#include<stdio.h>
int main(){
  int n,i,j, temp1, temp2;
  float atat =0, awt = 0;
  printf(" enter the number of process ");
  scanf("%d", &n);
  int atime1[n], btime2[n], ctime3[n], tattime4[n], wtimes[n], pid[n];
  printf(" enter process id's ")
  printf(" enter process ids");
  for(i=0; i<n; i++){
     scanf("%d", &pid[i]);
  }
  printf("enter 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] = pid[j+1];
           pid[j+1]
           pid[j+1] = temp2;
        }
     }
  }
```

e %d complete
time %d \n", i+1,
ne4[i], wtimes[i]);

turn around time 2
turn around time 3
turn around time 3
12 turn around time 6

```
}
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++){
    wtimes[i] = tattime4[i] - btime2[i];
}
for(i=0; i<n; i++){
    atat = atat + tattime4[i];
}
atat = (atat/n);
for(i=0;i<n);
for(i=0; i<n; i++){
    awt = awt + wtimes[i];
}
awt = (awt/n);
for(i=0; i<n; i++
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], tattime4[i],
        wtimes[i]);
}
```

```
        wtimes[i]);
    }
    printf(" average tur
    printf(" average wa
    return 0;
}
}
output:
enter the number of pro
enter process ids:
enter process ids 1
2
3
4
enter arrival times : 0
0
0
0
enter burst times 6
3
1
2
process id 4 arrival ti
process id 1 arrival tim
process id 3 arrival time
process id 2 arrival time
average turnaroundtime
average wait
average waiting time :
#include<stdio.h>
#define max 10
void
void sif
void sif(int n, int at[
{
    int ct[max];
    int tat[max];
    int wt[max];
    int total_wt;
    int total_wt = 0,
    int total_tat = 0,
    for(int i=0; i<n; i
    {
        ct[i]= -1;
    }
}
```

```
    wtimes[i]);
}
printf("average turnaround time %.f\n", atat);
printf("average waiting time %f\n", awt);
return 0;
}
```

output:

```
enter the number of processes 4
enter process ids 1
2
3
4
enter arrival times : 0
0
0
0
enter burst times 6
8
7
3
```

Process id 4 arrival time 0 burst time 3 complete time 3 turnaround time 3 waiting time 0

Process id 1 arrival time 0 burst time 6 complete time 9 turnaround time 9 waiting time 3

Process id 3 arrival time 0 burst time 7 complete time 16 turnaround time 16 waiting time 9

Process id 2 arrival time 0 burst time 8 complete time 24 turnaround time 24 waiting time 16

average turnaroundtime 13.000000

average waiting time : 7.000000

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

void sjf(int n, int at[], int bt[])
{
    int ct[max];
    int tat[max];
    int wt[max];
    int total_wt;
    int total_tat;
    for(int i=0; i<n; i++)
    {
        ct[i]=-1;
    }
```

```
for(int i=0; i<n; i++)
{
  for(int j=0; j<n; j++)
  {
    if (bt[j] > bt[j+1])
    {
      int temp = bt[j];
      bt[j] = bt[j+1];
      bt[j+1] = temp;
      int temp_at = at[j];
      at[j] = at[j+1];
      at[j+1] = temp_at;
    }
  }
}
for(int i=0; i<n; i++)
{
  if (current_time < at[i])
  {
    current_time = at[i];
  }
  ct[i] =
```

P-9
P-9

1) (c)

SJF (shortest job first)
preemptive

```
#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, i
    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
    while(completed_process
        int available_pr
        int available_co
        for(int i=0; i<n;
            if(at[i] <=
                availa
                availa
                availa
                availa
        }
    }
    if(available_cou
        current_ti
```

```
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_process[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 ++;
            }
        }
        if(available_count == 0){
            current_time ++;
```

```
            continue;
        }
        int shortest_Job_index = available_processes[find_min(rt,
                                                    available_num)];

        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 turnaround
            time \t waiting time \n");

    for(int i=0; i<n; i++){
        printf("%d
        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("\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 burst
    for(int i=0;

    printf("enter the arri
    for(int i=0; i<n; i++
        scanf("%d", &at

    }
    printf("enter the burs
    for(int i=0; i<n; i++
        scanf("%d", &bt[

    }
    SJF_Preemptive(n, at,
}
```

output

output

enter the number of proc

Output:

enter the number of pro
enter the arrival time
2
1
4
0
2
enter the burst time
1
5
1
6
3

process	arrival time	b
1	2	
2	1	
3	4	
4	0	
5	2	

average waiting time 4.

```
printf("enter the burst time \n");
for(int i=0;

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]);
}
sjf_preemptive(n, at, bt);

}
```

output

output:

enter the number of processes :

Output:

enter the number of process 5
enter the arrival time
2
1
4
0
2
enter the burst time
1
5
1
6
3

process	arrival time	burst time	completion time	turnaround time	waiting time
1	2	1	3	1	0
2	1	5	7	6	1
3	4	1	8	4	3
4	0	6	13	13	7
5	2	3	16	14	11

average waiting time 4.40

```
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[0];

for(int i=1; i<n; i++){
    ct[i] = ct[i-1] + bt[i];
    tat[i] = ct[i] - at[i];
    wt[i] = tat[i] - bt_copy[i];
    total_wt += wt[i];
    total_tat += tat[i];
}
printf("\n Process\t arrival time\t burst time\t priority\t completion time
        \t turnaroundtime\t waiting time\n");

for(int i=0; i<n; i++){
    printf("%d\t %d\t %d\t %d\t %d\t %d\t %d\t %d\n",
        i+1, at[i], bt_copy[i], p[i], ct[i], tat[i], wt[i]);
}
printf("\n average waiting time %.2f ", (float)total_wt/n);
printf("\n average turnaroundtime %.2f ", (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");
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]);
}
printf("enter the priority\n");
for(int i=0;i<n;i++){
    scanf("%d",&p[i]);
}
priority_non-preemptive(n,at,bt,p);
}
```

output:

```
enter the number of process 4
enter the arrival time
0
1
2
4
enter the burst time
5
4
2
1
enter the burst time
5
4
2
1
enter the priority
10
20
30
40
```

process	arrival time	burst time
1	4	5
2	2	4
3	1	2
4	0	1

average waiting time 5.00
average turnaround time 8.00

1

enter the priority

10

20

30

40

process	arrival time	burst time	priority	tat	wt	ct
1	4	5	40	1	4	5
2	2	4	30	5	1	7
3	1	2	20	10	8	11
4	0	1	10	16	15	16

average waiting time 5.00

average turnaround time 8.00

(b)
2) round robin (experiment with different quantum sizes for rr algorithm)
round robin scheduling.

```
#include<stdio.h>
struct process{
    int pid;
    int burst_time;
    int arrival_time;
    int remaining_time;
};
void roundrobin(struct process processes[], int n, int time_quantum){
    int remaining_processes = n;
    int current_time = 0;
    int completed[n];
    int ct[n], wt[n], tat[n], rt[n];
    for(int i=0; i<n; i++){
        completed[i]=0;
    }
    while(remaining_processes>0){
        for(int i=0; i<n; i++){
            if (completed[i] == 0 && processes[i].arrival_time <= current_time){
                if(processes[i].remaining_time >0){
                    if(processes[i].remaining_time <= time_quantum){
                        current_time += processes[i].remaining_time;
                        processes[i].remaining_time = 0;
                        completed[i] = 1;
                        remaining_processes --;
                        ct[i] = current_time;
                        tat[i] = ct[i] - processes[i].arrival_time;
                    }
                    else{
                        current_time += time_quantum;
                        processes[i].remaining_time -= time_quantum;
                    }
```

```
                }
                wt[i] = ct[i] - processes[i]
                rt[i] = wt[i];
            }
        }
    }
}
printf("Pid\tat\tbt\tct\twt\tt
float avg_tat=0, avg_wt=0;
for(int i=0; i<n; i++){
    printf("%d\t%d\t%d\t%d\t%d\t
    avg_tat += tat[i];
    avg_wt += wt[i];
}
avg_tat /= n;
avg_wt /= n;
printf("\naverage turnaround tim
printf("average waiting time
}
int main(){
    int n, time_quantum;
    printf("enter the number of
    scanf("%d", &n);
    printf("enter the time quant
    scanf("%d", &time_quantum
    struct process processes[n];
}
```

```
    }
    wt[i] = ct[i] - processes[i].arrival_time - processes[i].burst_time;
    rt[i] = wt[i];
  }
 }
}
printf("Pid\tat\tbt\tct\twt\ttat\trt\n");
float avg_tat = 0, avg_wt = 0;
for(int i=0; i<n; i++){
   printf("%d\t%d\t%d\t%d\t%d\t%d\t%d\n", processes[i].pid, processes[i].
                                          arrival_time, processes[i].burst_time,
                                          ct[i], wt[i], tat[i], rt[i]);

   avg_tat += tat[i];
   avg_wt += wt[i];
 }

 avg_tat /= n;
 avg_wt /= n;
 printf("\naverage turnaroundtime %.2f\n", avg_tat);
 printf("average waiting time %.2f\n", avg_wt);
}

int main(){
   int n, time_quantum;
   printf("enter the number of processes");
   scanf("%d", &n);
   printf("enter the time quantum");
   scanf("%d", &time_quantum);
   struct process processes[n];
}
```

```
printf("enter arrival time and burst time for each process\n");

printf("enter arrival time and burst time for each process\n");
for(int i=0;i<n;i++){
    printf("enter arrival time for process %d ",i+1);
    scanf("%d",&proce
    scanf("%d",&processes[i].arrival_time);
    printf("enter burst time for process %d",i+1);
    printf("enter burst time for process %d ",i+1);
    scanf("%d",&processes[i].burst_time);
    processes[i].
    processes[i].pid = i+1
    processes[i].remaining_time = processes[i].burst_time;
}
roundrobin
roundrobin(processes,n,time_quantum);

}
```

Output:

```
enter the number of processes 5
enter the time quantum 2
enter arrivaltime and burst time for each pr
enter arrival time and burst time for each process
enter arrival time for process 1 0
enter burst time for process 1 5
enter arrival time for process 2 1
enter burst time for process 2 3
enter arrival time for process 3 2
enter burst time for process 3 1
enter arrival time for process 4 3
enter burst time for process 4 2
enter arrival time for process 5 4
enter burst time
enter burst time for process 5 3
```

```
pid
```

pid	at	bt	ct
1	0	5	14
2	1	3	12
3	2	1	5
4	3	2	7
5	4	3	13

```
avg
```

average turnaroundtime = 8.2

average turnaroundtime : 8 2

average wai

average waitingtime 5.40

average turnaround time 8

average waiting time 5.4

earliest deadline first sche

earlpest deadline first schedulin

```
#
#include<stdio.h>
typedef struct{
    int capacity;
    int deadline;
    int period;
}task;
int compare_tasks(const voi
    task
    task* task1 = (task*
    task* task2 = (task*
    return (task1->dead
}
int main()
int main(){
    int num_tasks;
```

pid	at	bt	ct	wt	tat	rt
1	0	5	14	9	14	9
2	1	3	12	8	11	8
3	2	1	5	2	3	2
4	3	2	7	2	4	2
5	4	3	13	6	9	6

~~average turnaroundtime = 8.20~~

average turnaroundtime = 8.20

~~average wai~~

average ~~waiting~~time 5.40

average turnaround time 8.20

average waiting time 5.40

~~earliest deadline first sche~~

earliest deadline first scheduling :

```
#include<stdio.h>
typedef struct{
    int capacity;
    int deadline;
    int period;
}task;
int compare_tasks(const void* a, const void * b){
    ~~task * ta~~
    task* task1 = (task*)a;
    task* task2 = (task*)b;
    return (task1->deadline - task2->deadline);
}
~~int main(){~~
int main(){
    int num_tasks;
```

3)
lab-3 6/6/24
Write a C program to simulate the multilevel queue scheduling ~~algo~~ algorithm
multilevel queue

```
#include<stdio.h>
void findwaitingtime(int process[], 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 process[], int n, int bt[], int wt[], int tat[])
{
  for(int i=0;i<n;i++)
  {
    tat[i]= bt[i]+wt[i];
  }
}
```

```
Void roundrobin(int proce
{
int wt[n], tat[n], ct[n],
int remaining_bt[n];
int remaining_bt[n];
int completed=0;
int time=0;
for(int
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]
   {
     if(remai
     if(remaining_bt
     {
       if(remaining_bt[
       {
         time+= remaini
         remaining_bt[i]
         ct[i]=time;
         completed++;
       }
       else
       {
         time+= quantum
         remaining_bt[i]
       }
     }
   }
  }
}
```

duling ~~algo~~ algorithm

t at[], int wt[])

int wt[], ~~int tat~~]

```
void roundrobin(int process[], 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(process, n, bt, at, wt);
findturnaroundtime(process, n, bt, wt, tat);
printf("process burst time arrival time waiting time turnaround time
        completion completiontime \n");
for(int i=0; i<n; i++)
{
  printf("p%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 (round robin) = %f \n", (float)
                                                  total_wt/n);
printf("average turnaroundtime (round robin) = %f \n", (float)
                                                  total_tat/n);
}
```

```
void fcfs(int process[], int n
{
  int wt[n], tat[n], ct[n],
  findwaitingtime(
  findwaitingtime(process, n
  findturnaroundtime(process,
  printf("process burst 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
            process[i], bt[i],
    total_wt += wt[i];
    total_tat += tat[i];
  }
  printf("average waiting tim
  printf("average turnaround t
}
int main()
{
int process[] = {1,2,3,4,5};
int n = sizeof(process) / sizeof(
int bt = {10,5,8,12,15};
int at[] = {0,1,2,3,4};
int quantum = 2;
```

```
void fcfs(int process[], int n, int bt[], int at[])
{
  int wt[n], tat[n], ct[n], total_wt=0, total_tat=0;
  int wt[n], tat[n], ct[n], total_wt=0, total_tat=0;
  findwaitingtime(process, n, bt, at, wt);
  findturnaroundtime(process, n, bt, wt, tat);
  printf("process bursttime arrivaltime waitingtime turnaroundtime
        completion time \n");
  for(int i=0; i<n; i++)
  for(int i=0; i<n; i++)
  {
    ct[i]=at[i]+bt[i];
    printf("%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 process[]={1,2,3,4,5};
int n=sizeof(process)/sizeof(process[0]);
int bt={10,5,8,12,15};
int at[]={0,1,2,3,4};
int quantum=2;
```

~~int quan~~

~~int quantum;~~

int quantum = 2;

roundrobin (process, n, bt, at, quantum);

fcfs (process, n, bt, at);

}

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

~~average tt~~

Average wt (round robin) = 14.60

~~average turnaroundtime~~ 0

average 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	15
P5	15	4	29	44	19

Average wt (fcfs) = 14.60

Average tat (fcfs) = 24.6

(a) 4)

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 &&
      return max;
  }
  if(max%a==0 &&
      ~~return(max);~~
      return(max);
  }
  max++;
}
}
int is_schedulable(struct
{
  float utilization = 0.0
  for(int i=0;i<n;i++)
  {
    utilization += (float)
    process[i].time_peri
  }
  return (utilization <= 1.0
}
~~int main()~~
{
  struct process process[3
int main()
{
  struct processes process
  {
    {3,20};
    {2,5};
  }
```

```
int lcm(int a, int b)
{
  int max = (a>b)? a : b;
  while(1)
  {
  if(max % a == 0 && max % b == 0){
     return max;
  }
  if(max % a == 0 && max % b == 0){
      return(max);
  }
  max++;
 }
}
int is_schedulable(struct process process[], int n)
{
  float utilization = 0.0
  for(int i=0; i<n; i++)
  {
    utilization += (float) process[i].execution_time;
    process[i].time = period;
  }
  return (utilization <= 1.0);
}
int main()
{
  struct process process[]
int main()
{
  struct processes processes[] =
  {
     {3,20};
     {2,5};
     |
```

```
    {1,10},
    {2,10}};
int n = sizeof(process)/sizeof(process[0]);
if(!is_schedulable(processes,n))
{
  printf("the given set of process is not schedule\n");
  return 0;
}
int scheduling_time = lcm(processes[0].
int scheduling_time = lcm(processes[0].time_period, process[1].time_period);
printf("execution order\n");
if(t%.processes[1].time_period==0)
  printf(
if(t%.p0
if(t%.processes[1].time_period==0){
  printf("P2");
}
if(t%.processes[2].time_period==0){
  printf("P3");
}
if(t%.processes[2].time_period==0){
  printf("P3");
}
if(t%.process[0]
if(t%.processes[0].time_period==0){
  printf("P1");
}
}
}
printf("\n");
}
output:
exe
output:
execution or
output:
execution order
P2 P3 P1
output:
execution order
P2 P3 P1 P2 P2 P3 P2
```

(b)
earliest deadline first scheduling

```
#include<stdio.h>
#include<stdlib.h>
#include<math.h>
void sort(int proc[], int d[],
{
  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(
  }
  return lcm;
}
void main()
{
  int n;
  printf(" enter the numbe
  scanf("%d", &n);
  int proc[n], b[n], pt[n],
  printf(" enter the cpu bu
  for(int i=0; i<n; i++)
  {
    scanf(" %d", &b[i]);
    rem[i]= b[i];
  }
  printf(" enter the deadli
  for(int i=0; i<n; i++){
    scanf("%d", &d[i]);
  }
  printf(" enter the time pe
  for(int i=0; i<n; i++){
    proc[i]= i+1;
  }
  sort(proc, d, b, pt, n);
  int l= lcmul(pt, n);
  printf(" earliest deadline
  printf(" Pid \t burst \t dead
  for(int i=0; i<n; i++){
    printf("%d \t \t %d
          pt[i]);
}
```

```
    lcm = (lcm * pt[i])/gcd(lcm, pt[i]);
  }
  return lcm;
}
void main()
{
  int n;
  printf(" enter the number of process");
  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++){
    proc[i] = i+1;
  }
  sort(proc, d, b, pt, n);
  int l = lcmul(pt, n);
  printf(" earliest deadline scheduling \n");
  printf(" Pid \t burst \t deadline \t period \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;
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 % p[i] == 0 && time != 0)
   {
      nextdeadlines[i] = time + d[i];
      rem[i] = b[i];
   }
}
int mi
int mindeadline = l+1;
int task to
int tasktoexecute = -1;
for(int i=0; i<n; i++)
{
  if(rem[i] > 0 && nextdeadlines[i] < mindeadline)
  {
     mindeadline = nextdeadlines[i];
     task toexecute =
     tasktoexecute = i;
  }
}
if(tasktoexecute != -1)
{
  printf(" %d ms : task %d is running \n", time, proc[tasktoexecute]);
  rem[tasktoexecute]
  }
  else
  {
    printf("%d ms : cpu i
  }
  time++;
 }
}
```

output:

```
enter the number of process 3
enter cpu burst time
3
2
2
enter the deadlines
7
4
8
enter
enter the timeperiod
20
5
10
earliest deadline scheduling
Pid   burst   deadlines   pe
2     2       4
1     3       7
3     2       8
Scheduling occurs for 20ms
0ms : task 2 is running
1ms : task 2 is running
3ms : task 1 is running
2ms : task 1 is running
3ms : task 1 is running
4ms : task 1 is running
5ms : task 3 is running
6ms : task 3 is running
7ms : task 2 is running
8ms : task 2 is running
9ms : cpu is idle
```

```
        rem[task to execute]--;
    }
    else
    {
      printf("%d ms : cpu is idle to");
      printf("%d ms  cpu is idle \n", time);
    }
  }
  Enter 11;
 }
  time++;
 }
}
```

output:

enter the number of process 3
enter cpu burst time
3
2
2
enter the deadlines
7
4
8
enter
enter the timeperiod
20
5
10
earliest deadline scheduling

pid	burst	deadlines	period
2	2	4	5
1	3	7	20
3	2	8	10

Scheduling occurs for 20ms
0ms: task 2 is running
1ms: task 2 is running
3ms: task 1 is running
2ms: task 1 is running
3ms: task 1 is running
4ms: task 1 is running
5ms: task 3 is running
6ms: task 3 is running
7ms: task 2 is running
8ms: task 2 is running
9ms: CPU is idle

proc[task to execute]);

```
10 ms  task 2 is running
11 ms  task 2 is running
12 ms  task 3 is running
13 ms  task 3 is running
14 ms  cpu is idle
15 ms  task 2 is running
16 ms  task 2 is running
17 ms  cpu is idle
18 ms  cpu is idle
19 ms  cpu is idle
```

(c) proportional scheduling

```
#include<stdio.h>
#include<stdlib.h>
#include<time.h>
#define max_tasks 10
#define max_ticket 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_ticket = 10
    int total_ticket = 0;
    for(int i=0; i<num_tasks; i++){
        total_ticket += tasks[i].tickets;
    }
    srand(time(NULL));
    int current_time = 0;
    int completed = 10
    int c
    int completed_tasks = 0;
    printf("process scheduling \n");
    while(completed_tasks < num_tasks){
        int winning_ticket = rand() % total_tickets;
        if
```

```
int cumulative_ticket =
for(int i=0; i< num_tas
    cumulative_ticke
    if
    if(winning_ticke
    if (winn
    if (winning_tic
        printf("time
            cur
        current_time
        current_tim
        break;
    }
}
completed_tasks++;
}
*time_span_ms = current
}
int main(){
    struct task tasks[max_t
    int num_tasks;
    int time_span_ms;
    printf("enter the numbe
    scanf("%d", &num_tas
    if(num_tasks <= 0 || num
        printf("invalid numb
            1 and %d
        return;
        return(1);
}
```

```
int cumulative_tickets = 0;
for(int i=0; i< num_tasks; i++){
    cumulative_tickets += tasks[i].tickets;
    if(winning_ticket < cumulative_tickets)
    if(winn
    if (winning_ticket < (cumulative_tickets){
        printf("time %d - %d task %d is running\n",
                current_time, current_time+1, tasks[i].tid);
        current_time
        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 number between
            1 and %d \n", max_tasks);
    return(1);
  }
```

```
printf("enter
printf("enter number of tickets for each task \n");
for(int i=0; i<num_tasks; i++)
for(int i = 0, i< num_tasks; i++){
    tasks[i].tid = i+1;
    printf("task %d ticket
    printf("task %d ticket", tasks[i].tid);
    scanf(
    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
printf("\n time span of the gantt chart %d milliseconds \n",
                                    time_span_ms);
                                    time_span_ms);
}
```

output:

```
enter the number of tasks 3
enter the number of tickets for each task
task 1 tickets 10
task 2 tickets 20
task 3 tickets 30
running tasks
process schet
process scheduling
process scheduling
process scheduling
time 0-1 task 3 is running
time 1-2 task 3 is running
time 2-3 task 1 is running
```

time span of gantt chart

time span of gantt char

12-06-2024

5) write a c program to
Semaphores

```
#include<stdio.h>
#include<stdlib.h>
int mutex = 1, full = 0, empty
int mai
int main()
{
int n;
void producer();
void consumer();
int wait(int);
int signal(int);
printf("\n1. producer \n
while(1)
{
  printf"
  printf("\n enter your c
  printf("\n enter your ch
  scanf("%d",&n);
  switch(n)
  {
    case 1 : if((mu
    {
      pr
    }
    else{
    }
    break
    case 2 : if((m
    {
      co
```

time span of gantt chart

time span of gantt chart 300 milliseconds

12-06-2024

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("
printf("\n enter your choice");
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;
        }
        }
        break;

    case 3 :   exit(0);
               break;

      }
   }
}
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 item %d", x);
   mutex = signal(mutex);
}
void consumer()
{
```

```
void consumer()
{
   mutex = wait(mutex);
   full = wait(full);
   empty = signal(empty);
   printf("\nconsumer co
   x--;
   mutex = signal(mutex);
}
```

output:

```
1. producer
2. consumer
3. exit
enter your choice 1
Producer produces item 1
enter your choice 1
Producer produces item 2
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
```

```
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 1

producer

Producer produces item 1

enter your choice 1

producer

produ

Producer produces item 2

enter your choice 2

enter your choice 2

consumer consumes item 2

enter your choice 2

enter your choice 2

consumer consumes item 1

enter you

ente

enter your choice 2

buffer is empty

enter yo

buffer is empty

enter your choice 3

enter your choice 3

19/06/2024

6) write a c program to simulate the concept of dining philosophers problem

```
#include<stdio.h>
#include<stdlib.h>
#define max_philosophers 10
typedef enum{thinking, hungry, eating} state_t;
state_t states[max_philosophers];
int num_philosophers;
int num_hungry
int hungry_philosophers[
int hungry_philosophers[max_philosophers];
int forks[max_philosophers];
void print_state(){
    printf("\n");
    for(i=0;i<num_philosophers;++i){
        if(states[i]==thinking)
        {
            printf("P%d is think\n",i+1);
        }
        else if(states[i]==hungry)
        {
            printf("P%d is waiting\n",i+1);
        }
        else if(states[i]==eating)
        {
            printf("P%d is eating\n",i+1);
        }
    }
}
int can_eat(int philosopher_id){
    int left_fork=philosopher_i
    int left_fork=philosopher_id;
    int right_fork=(philosopher_id+1)%num_philosophers;
    if(forks[left_fork]==0&&forks[right_fork]==0){
        forks[left_fork]=forks[right_fork]=1;
        return(1);
    }
```

```
    return 0;
}
void simulate(int allow_hu
    int eating_count=0;
    for(int i=0;i<num_hu
        int philosopher_id=
        if(states[philosophe
            if(can_eat(phil
                states[phil
                eating_coun
                printf("P%
                if(!allow_h
                {
                    break;
                }
                if(allow_hu
                    break;
                }
            }
        }
    }
}
for(int i=0;i<num_h
    int philosopher_id
    if(states[philosoph
        int left_fork
        int rig
        int left_fork
        int right_for
    }
```

philosophers

```
    return 0;
}
void simulate(int allow_two){
    int eating_count = 0;

    for(int i = 0; i< num_hungry; ++i){
        int philosopher_id = hungry_philosophers[i];
        if(states[philosopher_id] == hungry){
            if(can_eat(philosopher_id)){

                states[philosopher_id] = eating;

                eating_count++;
                printf("P %d is granted to eat \n", philosopher_id +1);
                if(!allow_two && eating_count == 1)
                {
                    break;
                }
                if(allow_two && eating_count == 2){
                    break;
                }
            }
        }
    }
}

for(int i = 0; i<num_hungry ; i++){
    int philosopher_id = hungry_philosophers[i];

    if(states[philosopher_id] == eating){
        int left_fork = philosopher_id;
        int rig
        int left_fork = philosopher_id;
        int right_fork = (philospher_id +1) % num_philosophers;
    }
```

```
    }
    forks[left_fork] = forks[right_fork] = 0;
    states[philosopher_i]
    states[philosopher_id] = thinking;
  }
 }
}
int main(){
  printf(" enter the total number of philosophers (max %d) :", max_philosophers);
  scanf("%d", &num_philosophers);
  if(num_philosophers < 2 || num_philosophers > max_philosophers){
    printf(" invalid number
    printf("invalid number of philosophers exiting \n");
    return 1;
  }
  printf(" how many are hungry \n");
  printf(" how many are hungry ");
  scanf("%d", &num_hungry);
  for(int i=0; i< num_hungry ; i++){
    printf(" enter philosopher %d position",
    printf("enter philosopher %d position", i+1);
    int position;
    scanf("%d", &position);
    hungry_philosophers[i] = position-1;
    states[hungry_philosophers[i]] = hungry;
  }
  for(int i=0; i< num_philosophers ; i++
  for(int i=0; i<num_philosophers; i++){
    forks[i] = 0;
  }
```

```
  int choice;
  do{
    print_state();
    printf("\n1. one can eat at a ti
    printf("2 two can eat at a time
    printf("3 exit\n");
    printf(" enter your choice");
    printf(" enter your choice ");
    scanf("%d", &choice);
    switch(choice){
      case 1 : simulate(0);
               break;
      case 2 : simulate(1);
               break;
      case 3 : printf("exiting\n"
               break;
      default : printf("invalid ch
               break;
    }
  }while(choice!=3);
}
output:
output-
enter total number of philosophe
how many are hungry : 2
enter philosopher 1 position
enter philosopher 2 position
1. one can eat at a time
2. two can eat at a time
3. exit
enter your choice 1
P1 is granted to eat
```

```
int choice;
do{
print_state();
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 : simulate(0);
         break;
case 2 : simulate(1);
         break;
case 3 : printf("exiting\n");
         break;
default: printf("invalid choice please try again\n");
         break;
}
}while(choice!=3);
}
```

output:

```
enter total number 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 1
P1 is granted to eat
```

P4 is granted to eat

1. one can eat at a time
2. two can eat at a time
3. exit

enter your choice : 2

~~P1 and P4 are grd~~

P1 and P4 are granted to eat

1. one can eat at a time
2. two can eat at a time
3. exit

enter your choice : 3

7) Write a c program to simulate bankers algorithm for the purpose of deadlock avoidance

```
#include<stdio.h>
int P,R;
void avai(int all[P][R],int tot[R],int avail[R]){
    for(int j=0;j<R;j++){
        avail[j]=0;
        for(int k=0;k<P;k++){
            avail[j]+=all[k][j];
        }
    }
    for(int j=0;j<R;j++){
        avail[j]=tot[j]-avail[j];
    }
}
```

```
}
void need(int all[P][R], int max
    for(int i=0;i<P;i++){
        for(int j=0;j<R;j++){
            needmat[i][j]= max
        }
    }
}
void safety(int P, int R, int all[P]
    int f[P], c, count=0, h=0;
    for(int i=0;i<P;i++){
        f[i]=0;
    }
    while(count<P && h<P){
        for(int i=0;i<P;i++){
            if(f[i]==0){
                c=0;
                for(int j=0;j<
                    if(needmat[
                        c=(+1);
                    }
                }
                if(c==R){
                    printf("P%d is
                    for(int k=0;k
                        avail[k]+=
                        avail[k]+=
```

the purpose of deadlock

```
}
void need(int all[P][r], int max[P][r], int needmat[P][r]){
   for(int i=0;i<P;i++){
      for(int j=0; j<r; j++){
         needmat[i][j]= max[i][j]-all[i][i];
      }
   }
}
void safety(int P, int r, int all[P][r], int avail[r], int needmat[P][r], int seq[P]){
   int f[P], c, count=0, h=0;
   for(int i=0; i<P; i++){
      f[i]=0;
   }
   while(count<P && h<P){
      for(int i=0; i<P; i++){
         if(f[i]==0){
            c=0;
            for(int j=0; j<r; j++){
               if(needmat[i][j]<=avail[j]){
                  c=c+1;
               }
            }
            if(c==r){
               printf("P %d is visited(\t", i);
               for(int k=0; k<r; k++){
                  avail[k]+=
                  avail[k]+= all[i][k];
```

```
                printf("%d",
                printf("%d", avail[k]);
                printf("%d"
                printf("%d", avail[k]);
                printf("\t");
            }
            printf(")\n");
            f[i]=1;
            count=count+1;
            seq[h]=i;
            h=h+1;
        }
    }
}
}
int main(){
    printf("enter the number of processes");
    scanf("%d",&p);
    printf("enter the number of resources");
    scanf("%d",&r);
    int tot[r], needmat[p][r], avail[r], seq[p];
    printf("enter the total instances of each resource");
    for(int i=0;i<r;i++)
    for(int i=0;i<r;i++){
        scanf("%d",&tot[i]
        scanf("%d", &tot[i]);
        scanf("%d",&tot[i]);
}
tot
int all[p][r], max[p][r];
}
```

```
printf
printf("enter details of each pro
for
for(int i=0;i<p;i++){
    for(int j=0;j<r;j++){
        scanf("%d",&all[i][j]
    }
}
printf("enter maximum matrix
for(int i=0;i<p;i++){
    for(int j=0;j<r;j++){
        scanf("%d",&max[i][j]
    }
}
avail(all,tot,avail);
avail(all,tot,avail);
need(all,max,needmat)
need(all,max,needmat);
printf("need matri
printf("
printf(" need matrix\n");
for(int i=0;i<p;i++){
    for(int j=0;j<r;j++){
        printf("%d\t",needmat
    }
    printf("\n");
    Printf("\n");
}
Safety(p,r,all,avail,needmat,seq
printf("safe sequence is
Printf("safe sequence is ");
}
```

```
printf("enter details of each process (allocation matrix)\n");
for(int i=0; i<p; i++){
    for(int j=0; j<r; j++){
        scanf("%d", &all[i][j]);
    }
}
printf("enter maximum matrix\n");
for(int i=0; i<p; i++){
    for(int j=0; j<r; j++){
        scanf("%d", &max[i][j]);
    }
}
avail(all, tot, avail);
need(all, max, needmat);
printf("
printf(" need matrix\n");
for(int i=0; i<p; i++){
    for(int j=0; j<r; j++){
        printf("%d\t", needmat[i][j]);
    }
    printf("\n");
}
Safety(p, r, all, avail, needmat, seq);
Printf("Safe sequence is ");
```

~~for(int i=0; i<p; i++){~~

~~for(int i=0~~

```
for(int i=0;i<p;i++){
    printf("p%d|",seq[i]);
}
}
```

output:

enter the number of processes 5
enter the number of resources 3
enter the available resources 3 3 2
enter maximum resources for each processes 7 5 3
3 2 2
9 0 2
2 2 2
4 3 3
~~enter the allocated proc~~
enter the allocated resources for each processes 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

~~Safety sequence P2 P3~~

Safety sequence P2 P3 P4 P5 P1

3/7

03/07/2024

8) write a c program to simulate deadlock detection

~~#includecs~~

```
#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);
scanf("%d %d",&n,&m);
int max[n][m], need[n][m
c=0;
printf("enter the maximum
      each process \n");

for(i=0;i<n;i++)
{
  for(j=0;j<m;j++)
  {
    scanf("%d",&max[i
  }
}
printf("enter the allocated
      each process \n");
for(i=0;i<n;i++)
{
  for(j=0;j<m;j++)
  {
    scanf("%d",&all[i
  }
}
printf("enter the available 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
  }
}
}
```

```
scanf("%d %d",&n,&m);
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=c+1;
                if(c==m)
                {
                    for(j=0;j<m;j++)
                    {
                        ava[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=j+1;
        flag=1;
    }
}
if(flag==1)
{
    printf(" deadlock has occur
    printf(" the deadlock proces
    printf(" the deadlock proces
    for(i=0;i<n;i++)
    {
        printf("%d", dead[i
    }
}
else
{
    printf(" no deadlock has
}
}
```

Output:

```
enter the number of proces
s 3
enter the maximum number
each process
```

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

Output:

enter the number of process 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 eac

enter the allocated number of each type of resource 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 resource

3 3 2

no deadlock has occurred

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 ma
printf("file_no\t fi
for(int i=0; i<n_file
    for(int j=0; j<
        if(blocks[j
    }
}
}
void worstfit(struct block bl

printf("memory manag
printf("file_no\t file_
for(int i=0; i<n_files
    int worst_fit_block
    int max_fragment
    for(int j=0; j<n_
        if(blocks[j].i
            int fragm
            if(fragm
```

```
printf("memory management scheme - first fit\n");
printf("file_no\t file_size\t block_no\t block_size\t fragment\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\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\t file_size\t block_no\t block_size\t fragment\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\t file_size\t block_no\t block_size\t fragment\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 frag;
                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_fi]. bloc
        printf("%d\t\t%d\t
            files[i].file_si
            blocks[best_
        }
    }
}
int main(){
    int n_blocks, n_files;
    printf("enter number of
    scanf("%d", &n_blocks)
    printf("
    printf("enter number of
    scanf("%d", &n_files);
    struct block blocks[n_bl
    for(int i=0; i<n_blocks
    {
        blocks[i].block_no =
        printf("enter size of
        blocks[i].is_free = 1;
    }
    struct file files[
    struct file files[n_files]
    for(int i=0; i<n_files;
        printf("enter size of
        scanf("%d", &files[
    }
    firstfit(blocks, n_blocks, fi
```

```
        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].file_size, min_fragment);
    }
}

int main(){
    int n_blocks, n_files;
    printf("enter number of blocks ");
    scanf("%d", &n_blocks);
    printf("enter 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 size of block %d", i+1);
        blocks[i].is_free = 1;
    }
    struct file files[n_files];
    for(int i = 0; i<n_files; i++){
        printf("enter 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);
}
bestfit(blocks, n_blocks, files, n_files);
}
```

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	

10/07/2024

10) write a c program to simulate pag
memory management

```
#include<stdio.h>
#include<limits.h>
#include<stdlib.h>
void print_frames(int frame[], int capacity,
    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("PF no %d", page_faults);
    }
    printf("\n");
}
void fifo(int pages[], int n, int capacity)
    int frame[capacity], index=0, page_fa
    for(int i=0; i< capacity; i++)
    {
        frame[i]=-1;
    }
    printf("Fifo page replacement Process
    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;
            }
    }
```

10/07/2024

10) write a c program to simulate paging technique of ~~memory management~~ memory management

```
#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(" 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 Processes \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;
           }
   }
```

Fragment
4
3

Fragment
6
1

Fragment
1

```
        if(!found){
            frame[index] = pages[i];
            index = (index+1) % capacity;
            page_faults++;
        }
        print_frames(frame, capacity, found?0: page_faults);
    }
    printf("total page faults %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
}
void optimal(int pages[], int n,
    int frame[capacity], page_
    for(int i=0; i<capacity; i+
    {
        frame[i]=-1;
    }
    printf("optimal page repl
    for(int i=0; i<n; i++){
        int found=0;
        for(int j=0, j<capaci
            if(frame[j]==
                found=1;
                break;
                break;
            }
        }
        if(!found){
            int farthest=i+1
            for(int j=0; j<co
                int k;
                for(k=i+1; k
                    if(frame
                    {
                        brea
                    }
```

```
            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;~~
                ~~}~~;
                break;
            }
        }
        if(!found){
            int farthest = i+1, index = -1;
            ~~for(int j=0; j<capacity; j~~++
            for(int j=0; j< capacity; j++){
                int k;
                ~~for(k=i+1;~~
                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);
printf("total page faults using Ophimal %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)
    for(int i=0; i<n; i++){
        scanf("%d", &pages[i]);
    }
    printf("enter the frame capacity ");
    scanf("%d",
    scanf("%d"
    Scanf("%d", &capacity);
    printf("\n Pages ");
    for(int i=0; i<n; i++){
        printf("%d", pages[i]);
    }
    printf("\n\n");
    fifo(pages, n, capacity);
    fifo(pages, n, capacity);
    lru(pages, n, capacity);
    ophimal(pages, n, capacity);
    Secfo
    free(pages);
}
```

output :

```
enter the number of pages 20
enter the pages 7,0,1,2,0,3,0
enter the frame capacity 3
pages: 7 0 1 2 0 3 0 4 2 3 0
fifo page
```

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

```
    for(int i=0; i<n; i++){
        printf("%d", pages[i]);
    }
    printf("\n\n");
    ~~fifo(pages, n, capacity);~~
    fifo(pages, n, capacity);
    lru(pages, n, capacity);
    optimal(pages, n, capacity);
    ~~fcfs();~~
    free(pages);
}
```

output :

enter the number of pages 20
enter the pages 7,0,1,2,0,3,0,4,2,3,0,3,2,1,2,0,1,7,0,1
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~~ 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~~
~~4 2 0~~
4 3 0 - ~~pf no 7~~ 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 faulb using fifo 15

~~lru page replacement process~~:

lru page replacement process:

7 – –	pf no 1
0 – –	pf no 2
0 1 –	pf no 3
0 1 2	pf no 4
0 3 2	pf no 5
0 3 2	~~pf no 5~~
0 3 4	pf no 6
0 2 4	~~pf no 6~~
3 2 4	pf no 7
3 2 0	pf no 8
3 2 0	pf no 9
3 2 1	
3 2 1	
0 2 1	pf no 10
0 2 1	
0 7 1	
0 7 1	
0 7 1	

7 – –	pf no 1
0 – –	pf no 2
0 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 0	
3 2 1	pf no 10
3 2 1	~~pf no 10~~
0 2 1	pf no 11
0 2 1	~~pf no 11~~
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~~ 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	

8/7 complete

~~total page faults of~~

total page faults using optimal 9

Colour Me