VISVESVARAYA TECHNOLOGICAL UNIVERSITY

“JnanaSangama”, Belgaum -590014, Karnataka.

LAB REPORT on

OPERATING SYSTEMS

(23CS4PCOPS)

Submitted by

SHAMARAO (1BM23CS308)

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Bull Temple Road, Bangalore 560019
(Affiliated To Visvesvaraya Technological University, Belgaum)
Department of Computer Science and Engineering

CERTIFICATE

This is to certify that the Lab work entitled “OPERATING SYSTEMS – 23CS4PCOPS” carried out by **SHAMARAO (1BM23CS308),** who is Bonafide student of **B. M. S. College of Engineering.** It is in partial fulfillment for the award of **Bachelor of Engineering in Computer Science and Engineering** of the Visvesvaraya Technological University, Belgaum during the year 2025. The Lab report has been approved as it satisfies the academic requirements in respect of a **OPERATING SYSTEMS - (23CS4PCOPS)** work prescribed for the said degree.

Dr.**Shyamala G**	**Dr. Kavitha Sooda**
Assistant Professor Department of CSE BMSCE, Bengaluru	Professor and Head Department of CSE BMSCE, Bengaluru

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Course Outcome

CO1	Apply the different concepts and functionalities of Operating System

CO2	Analyze various Operating system strategies and techniques
CO3	Demonstrate the different functionalities of Operating System
CO4	Conduct practical experiments to implement the functionalities of Operating system

Program -1

Question:

Write a C program to simulate the following CPU scheduling algorithm to find turnaround time and waiting time. (Any one) a) FCFS

b) SJF

Code:

a) FCFS

```
#include <stdio.h>
int main() {
   int bt[20], wt[20], tat[20],
at[20];     float wtavg = 0, tatavg =
0;     int n, i;
   printf("Enter the number of processes: ");
scanf("%d", &n);

   printf("Enter the arrival time and burst time for each process:\n");
for (i = 0; i < n; i++) {
       printf("Process %d - Arrival Time: ", i + 1);
scanf("%d", &at[i]);
       printf("Process %d - Burst Time: ", i + 1);
scanf("%d", &bt[i]);
   }     wt[0] = 0;
tat[0] = bt[0];     for (i =
1; i < n; i++) {
       wt[i] = wt[i - 1] + bt[i - 1] -
at[i];         if (wt[i] < 0) wt[i] = 0;
tat[i] = wt[i] + bt[i];         wtavg +=
wt[i];         tatavg += tat[i];
   }
   printf("\nFCFS Scheduling\n");
   printf("Process\tArrival Time\tBurst Time\tWaiting Time\tTurnaround Time\n");
for (i = 0; i < n; i++) {
```

```
        printf("%d\t%d\t\t%d\t\t%d\t\t%d\n", i + 1, at[i], bt[i], wt[i], tat[i]);
}

    printf("\nAverage Waiting Time: %.2f\n", wtavg / n);
printf("Average Turnaround Time: %.2f\n", tatavg / n);

    return 0;
}
```

b) SJF

```
#include <stdio.h>

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

    int bt[n], wt[n], tat[n], at[n];
float wtavg = 0, tatavg = 0;

    printf("Enter the arrival time and burst time for each process:\n");
for (i = 0; i < n; i++) {
        printf("Process %d - Arrival Time: ", i + 1);
scanf("%d", &at[i]);
        printf("Process %d - Burst Time: ", i + 1);
scanf("%d", &bt[i]);
    }
    for (i = 0; i < n - 1; i++) {
for (j = i + 1; j < n; j++) {
if (bt[i] > bt[j]) {
temp = bt[i];                bt[i] =
bt[j];              bt[j] = temp;
```

```
temp = at[i];                 at[i] =
at[j];                 at[j] = temp;
            }
        }
    }

    wt[0] = 0;     for (i =
1; i < n; i++) {
        wt[i] = wt[i - 1] + bt[i - 1] - at[i];
if (wt[i] < 0) wt[i] = 0;
    }

    for (i = 0; i < n; i++) {
tat[i] = bt[i] + wt[i];
wtavg += wt[i];
tatavg += tat[i];
    }

    printf("\nSJF (Non-Preemptive) Scheduling\n");
    printf("Process\tArrival Time\tBurst Time\tWaiting Time\tTurnaround Time\n");
for (i = 0; i < n; i++) {
        printf("%d\t%d\t\t%d\t\t%d\t\t%d\n", i + 1, at[i], bt[i], wt[i], tat[i]);
}

    printf("\nAverage Waiting Time: %.2f\n", wtavg / n);
printf("Average Turnaround Time: %.2f\n", tatavg / n); }
```

Result:

```
Enter the number of processes: 4
Enter the arrival time and burst time for each process:
Process 1 - Arrival Time: 1
Process 1 - Burst Time: 5
Process 2 - Arrival Time: 2
Process 2 - Burst Time: 3
Process 3 - Arrival Time: 3
Process 3 - Burst Time: 1
Process 4 - Arrival Time: 4
Process 4 - Burst Time: 7

FCFS Scheduling
Process Arrival Time    Burst Time      Waiting Time    Turnaround Time
1       1               5               0               5
2       2               3               3               6
3       3               1               3               4
4       4               7               0               7

Average Waiting Time: 1.50
Average Turnaround Time: 4.25
```

```
Enter the number of processes: 4
Enter the arrival time and burst time for each process:
Process 1 - Arrival Time: 1
Process 1 - Burst Time: 5
Process 2 - Arrival Time: 2
Process 2 - Burst Time: 3
Process 3 - Arrival Time: 3
Process 3 - Burst Time: 1
Process 4 - Arrival Time: 4
Process 4 - Burst Time: 7

SJF (Non-Preemptive) Scheduling
Process Arrival Time    Burst Time      Waiting Time    Turnaround Time
1       3               1               0               1
2       2               3               0               3
3       1               5               2               7
4       4               7               3               10

Average Waiting Time: 1.25
Average Turnaround Time: 5.25
```

Program -2

Question:

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.

Code:

a)using FCFS

```
 #include <stdio.h>


int main() {
   int bt[20], wt[20], tat[20], ct[20], queue[20];
int n;
```

```
    float wtavg = 0, tatavg = 0;      int
sys_bt[20],   user_bt[20];             int
sys_count = 0, user_count = 0;

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

    for (int i = 0; i < n; i++) {
        printf("Enter Burst Time for Process %d: ", i + 1);
scanf("%d", &bt[i]);
        printf("Enter Queue Number (1 = System, 2 = User) for Process %d: ", i + 1);
scanf("%d", &queue[i]);

        if (queue[i] == 1) {
sys_bt[sys_count++] = bt[i];         }
else if (queue[i] == 2) {
user_bt[user_count++] = bt[i];
        }
    }
```



```
    int total_count = 0;
int current_time = 0;

    for (int i = 0; i < sys_count; i++)
{         if (total_count == 0) {
wt[total_count] = 0;          } else {
            wt[total_count] = current_time;
        }

        tat[total_count] = wt[total_count] + sys_bt[i];
ct[total_count] = current_time + sys_bt[i];
```

```
        current_time = ct[total_count];

        wtavg += wt[total_count];
tatavg += tat[total_count];
total_count++;
    }

    for (int i = 0; i < user_count; i++)
{         if (total_count == 0) {
wt[total_count] = 0;          } else {
            wt[total_count] = current_time;
        }

        tat[total_count] = wt[total_count] + user_bt[i];
ct[total_count] = current_time + user_bt[i];

        current_time = ct[total_count];
wtavg += wt[total_count]; tatavg +=
tat[total_count];

        total_count++;
    }

    printf("\nPROCESS\tBURST TIME\tQUEUE\tCOMPLETION
TIME\tWAITING TIME\tTURNAROUND TIME\n");      int sys_index = 0,
user_index = 0;      for (int i = 0; i < total_count; i++) {          if (sys_index <
sys_count) {
            printf("%d\t%d\t\tSystem\t%d\t\t%d\t\t%d\n", i + 1, sys_bt[sys_index], ct[i], wt[i], tat[i]);
sys_index++;
        } else if (user_index < user_count) {
            printf("%d\t%d\t\tUser\t%d\t\t%d\t\t%d\n", i + 1, user_bt[user_index], ct[i], wt[i], tat[i]);
user_index++;
        }
```

```
    }

    printf("\nAverage Waiting Time: %.2f", wtavg / total_count);
printf("\nAverage Turnaround Time: %.2f\n", tatavg / total_count);

    return 0;
}
```

b)using Round robin

```
#include <stdio.h>
void roundRobin(int bt[], int n, int quantum, int queue[], int sys_count, int user_count) {
int remaining_bt[20];
    int wt[20] = {0}, tat[20] = {0}, ct[20] =
{0};     int total_count = sys_count +
user_count;     int queue_index = 0;     int
current_time = 0, total_bt = 0;     float wtavg
= 0, tatavg = 0;

    for (int i = 0; i < total_count; i++) {
        remaining_bt[i] = bt[i];
        total_bt += bt[i];
    }

    while (total_bt > 0) {
        for (int i = 0; i < total_count; i++) {
if (remaining_bt[i] > 0) {
                int time_slice = (remaining_bt[i] <= quantum) ? remaining_bt[i] :
quantum;                current_time += time_slice;                remaining_bt[i] -=
time_slice;                total_bt -= time_slice;

                if (remaining_bt[i] == 0) {
ct[i] = current_time;                    tat[i] =
```

```
ct[i] - (total_bt - bt[i]);                    wt[i]
= tat[i] - bt[i];
                }
            }
        }
    }

    for (int i = 0; i < total_count; i++)
{         wtavg += wt[i];         tatavg
+= tat[i];
    }

    printf("\nPROCESS\tBURST TIME\tQUEUE\tCOMPLETION TIME\tWAITING
TIME\tTURNAROUND TIME\n");
    for (int i = 0; i < total_count; i++) {
if (queue[i] == 1) {
            printf("%d\t%d\t\tSystem\t%d\t\t%d\t\t%d\n", i + 1, bt[i], ct[i], wt[i], tat[i]);
        } else if (queue[i] == 2) {
            printf("%d\t%d\t\tUser\t%d\t\t%d\t\t%d\n", i + 1, bt[i], ct[i], wt[i], tat[i]);
        }
    }

    printf("\nAverage Waiting Time: %.2f", wtavg / total_count);
printf("\nAverage Turnaround Time: %.2f\n", tatavg / total_count);
}

int main() {     int
bt[20], queue[20];
int n, quantum;
    int sys_count = 0, user_count = 0;

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

```
    for (int i = 0; i < n; i++) {
        printf("Enter Burst Time for Process %d: ", i + 1);
scanf("%d", &bt[i]);
        printf("Enter Queue Number (1 = System, 2 = User) for Process %d: ", i + 1);
scanf("%d", &queue[i]);

        if (queue[i] == 1) {
sys_count++;        } else if
(queue[i] == 2) {
user_count++;
        }
    }

    printf("Enter the Time Quantum: ");
scanf("%d", &quantum);

    roundRobin(bt, n, quantum, queue, sys_count, user_count);

    return 0;
}
```

Result:

```
Enter the number of processes: 5
Enter Burst Time for Process 1: 4
Enter Queue Number (1 = System, 2 = User) for Process 1: 2
Enter Burst Time for Process 2: 7
Enter Queue Number (1 = System, 2 = User) for Process 2: 1
Enter Burst Time for Process 3: 8
Enter Queue Number (1 = System, 2 = User) for Process 3: 1
Enter Burst Time for Process 4: 1
Enter Queue Number (1 = System, 2 = User) for Process 4: 2
Enter Burst Time for Process 5: 4
Enter Queue Number (1 = System, 2 = User) for Process 5: 1

PROCESS BURST TIME      QUEUE   COMPLETION TIME WAITING TIME    TURNAROUND TIME
1       7               System  7               0               7
2       8               System  15              7               15
3       4               System  19              15              19
4       4               User    23              19              23
5       1               User    24              23              24

Average Waiting Time: 12.80
Average Turnaround Time: 17.60
```

```
Enter the number of processes: 5
Enter Burst Time for Process 1: 4
Enter Queue Number (1 = System, 2 = User) for Process 1: 2
Enter Burst Time for Process 2: 7
Enter Queue Number (1 = System, 2 = User) for Process 2: 1
Enter Burst Time for Process 3: 8
Enter Queue Number (1 = System, 2 = User) for Process 3: 1
Enter Burst Time for Process 4: 1
Enter Queue Number (1 = System, 2 = User) for Process 4: 2
Enter Burst Time for Process 5: 4
Enter Queue Number (1 = System, 2 = User) for Process 5: 1
Enter the Time Quantum: 3

PROCESS BURST TIME      QUEUE   COMPLETION TIME WAITING TIME    TURNAROUND TIME
1       4               User    14              4               8
2       7               System  22              20              27
3       8               System  24              24              32
4       1               User    10              -4              -3
5       4               System  21              18              22

Average Waiting Time: 12.40
Average Turnaround Time: 17.20
```

Program -3

Question:

Write a C program to simulate Real-Time CPU Scheduling algorithms
a) Rate- Monotonic

Code:

```
#include <stdio.h>

#include <stdlib.h>

#include <stdbool.h>


#define MAX_TASKS 10


typedef struct {     int

id;     int

execution_time;

int period;     int

time_remaining;

int next_start_time;

} Task;


// Function to calculate GCD int

gcd(int a, int b) {     return (b == 0)

? a : gcd(b, a % b);
```

```
}

// Function to calculate LCM of all task
periods int find_lcm(int periods[], int n) {
int lcm = periods[0];     for (int i = 1; i < n;
i++) {
        lcm = (lcm * periods[i]) / gcd(lcm, periods[i]);
    }
return lcm;
}

void rate_monotonic(Task tasks[], int n) {
int periods[MAX_TASKS];
    for (int i = 0; i < n; i++) {
periods[i] = tasks[i].period;
    }

    int simulation_time = find_lcm(periods, n); // Set simulation time to LCM of periods
printf("\nRate-Monotonic Scheduling (Simulating till time = %d):\n", simulation_time);

    for (int time = 0; time < simulation_time; time++) {
int chosen_task = -1;

        // Check if any task arrives at this time
for (int i = 0; i < n; i++) {
            if (time == tasks[i].next_start_time) {
                tasks[i].time_remaining = tasks[i].execution_time;
tasks[i].next_start_time += tasks[i].period;
            }
        }
```

```
        // Pick the highest-priority (shortest period) ready
task        for (int i = 0; i < n; i++) {            if
(tasks[i].time_remaining > 0) {
                if (chosen_task == -1 || tasks[i].period < tasks[chosen_task].period) {
chosen_task = i;
                }
            }
        }

        // Execute the chosen task or idle
        if (chosen_task != -1) {
            printf("Time %d: Task %d\n", time, tasks[chosen_task].id);
tasks[chosen_task].time_remaining--;
        } else {
            printf("Time %d: Idle\n", time);
        }
    }
}

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

    Task tasks[MAX_TASKS];
    for (int i = 0; i < n; i++) {
        printf("Enter execution time and period for Task %d: ", i +
1);        scanf("%d %d", &tasks[i].execution_time,
&tasks[i].period);        tasks[i].id = i + 1;
tasks[i].time_remaining = 0;        tasks[i].next_start_time = 0;
    }
```

```
    rate_monotonic(tasks, n);
return 0;
}
```

Result:

```
Enter the number of tasks: 2
Enter execution time and period for Task 1: 4
8
Enter execution time and period for Task 2: 1
4

Rate-Monotonic Scheduling (Simulating till time = 8):
Time 0: Task 2
Time 1: Task 1
Time 2: Task 1
Time 3: Task 1
Time 4: Task 2
Time 5: Task 1
Time 6: Idle
Time 7: Idle
```

Program -4

Question:

Write a C program to simulate:

a) Producer-Consumer problem using semaphores.

b) Dining-Philosopher's problem

Code:

a) Producer-Consumer problem using semaphores.

```
#include <stdio.h>

#include <stdlib.h>

#include <pthread.h>

#include <semaphore.h>


#define MAX_ITEMS 5

#define BUFFER_SIZE 5


int buffer[BUFFER_SIZE];

int in = 0, out =

0;      sem_t

mutex; sem_t

full; sem_t

empty;

int produced_count = 0, consumed_count = 0;


void *producer(void *arg) {

sem_wait(&empty);

sem_wait(&mutex);


   buffer[in] = produced_count + 1;       printf("Producer

has produced: Item %d\n", buffer[in]);     in = (in + 1) %

BUFFER_SIZE;       produced_count++;

sem_post(&mutex);
```

```
    sem_post(&full);
pthread_exit(NULL);
}

void *consumer(void *arg) {
sem_wait(&full);
sem_wait(&mutex);

    int last_item_index = (in - 1 + BUFFER_SIZE) % BUFFER_SIZE;
printf("Consumer has consumed: Item %d\n", buffer[last_item_index]);
buffer[last_item_index] = 0;     consumed_count++;

    in = (in - 1 + BUFFER_SIZE) % BUFFER_SIZE;

    sem_post(&mutex);
sem_post(&empty);
pthread_exit(NULL);
}

int main() {
    pthread_t prod_thread, cons_thread;
int choice;

    sem_init(&mutex, 0, 1);
sem_init(&full, 0, 0);
sem_init(&empty, 0, MAX_ITEMS);
while (1) {
        printf("Enter        1.Producer        2.Consumer
3.exit\n");                        printf("Enter   choice:   ");
scanf("%d", &choice);
        switch (choice) {
case 1:
```

```
                if (produced_count < MAX_ITEMS) {
                    pthread_create(&prod_thread, NULL, producer, NULL);
pthread_join(prod_thread, NULL);
                } else {
                    printf("Buffer is full. Cannot produce more items.\n");
                }
break;
case 2:
                if (consumed_count < produced_count) {
pthread_create(&cons_thread, NULL, consumer, NULL);
pthread_join(cons_thread, NULL);
                } else {
                    printf("Buffer is empty. Cannot consume more items.\n");
                }
break;
case 3:

sem_destroy(&mutex);
sem_destroy(&full);
sem_destroy(&empty);
return 0;               default:
                printf("Invalid choice.\n");
        }
    }

    return 0;
}
```

b) Dining-Philosopher's problem

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

```
#include <unistd.h>

#define NUM_PHILOSOPHERS 5
#define THINKING 0
#define HUNGRY 1
#define EATING 2

int state[NUM_PHILOSOPHERS];
int
phil_ids[NUM_PHILOSOPHERS];

sem_t mutex;
sem_t S[NUM_PHILOSOPHERS];

void test(int i) {     if (state[i]
== HUNGRY &&
        state[(i + 4) % NUM_PHILOSOPHERS] != EATING &&
state[(i + 1) % NUM_PHILOSOPHERS] != EATING) {

        state[i] = EATING;
sleep(1);
        printf("Philosopher %d takes forks %d and %d and starts eating\n", i + 1, (i + 4) %
NUM_PHILOSOPHERS + 1, i + 1);
        sem_post(&S[i]);
    }
}

void take_fork(int i) {
sem_wait(&mutex);
state[i] = HUNGRY;
    printf("Philosopher %d is hungry\n", i + 1);
test(i);
```

```
    sem_post(&mutex);
sem_wait(&S[i]);
sleep(1);
}

void put_fork(int i) {
sem_wait(&mutex);
state[i] = THINKING;
    printf("Philosopher %d puts down forks %d and %d and starts thinking\n", i + 1, (i + 4)
% NUM_PHILOSOPHERS + 1, i + 1);      test((i + 4) % NUM_PHILOSOPHERS);
test((i + 1) % NUM_PHILOSOPHERS);      sem_post(&mutex);
}

void* philosopher(void* num) {
int i = *(int*)num;

    while (1) {
        printf("Philosopher %d is thinking\n", i +
1);         sleep(1);         take_fork(i);
sleep(2);          put_fork(i);
    }

    return NULL;
}

int main() {
    int i;
    pthread_t thread_id[NUM_PHILOSOPHERS];
    sem_init(&mutex, 0, 1);

    for (i = 0; i < NUM_PHILOSOPHERS; i++)
{         sem_init(&S[i], 0, 0);         phil_ids[i] =
i;
```

```
    }

    for (i = 0; i < NUM_PHILOSOPHERS; i++) {
        pthread_create(&thread_id[i], NULL, philosopher, &phil_ids[i]);
printf("Philosopher %d is seated at the table\n", i + 1);
    }

    for (i = 0; i < NUM_PHILOSOPHERS; i++) {
pthread_join(thread_id[i], NULL);
    }

    return 0;
}
```

Result:

```
Enter 1.Producer 2.Consumer 3.exit
Enter choice: 1
Producer has produced: Item 1
Enter 1.Producer 2.Consumer 3.exit
Enter choice: 1
Producer has produced: Item 2
Enter 1.Producer 2.Consumer 3.exit
Enter choice: 1
Producer has produced: Item 3
Enter 1.Producer 2.Consumer 3.exit
Enter choice: 1
Producer has produced: Item 4
Enter 1.Producer 2.Consumer 3.exit
Enter choice: 2
Consumer has consumed: Item 4
Enter 1.Producer 2.Consumer 3.exit
Enter choice: 2
Consumer has consumed: Item 3
Enter 1.Producer 2.Consumer 3.exit
Enter choice: 2
Consumer has consumed: Item 2
Enter 1.Producer 2.Consumer 3.exit
Enter choice: 2
Consumer has consumed: Item 1
Enter 1.Producer 2.Consumer 3.exit
Enter choice: 2
Buffer is empty. Cannot consume more items.
Enter 1.Producer 2.Consumer 3.exit
Enter choice: 3
```

```
Philosopher 1 is seated at the table
Philosopher 2 is seated at the table
Philosopher 3 is seated at the table
Philosopher 4 is seated at the table
Philosopher 5 is seated at the table
Philosopher 1 is thinking
Philosopher 2 is thinking
Philosopher 3 is thinking
Philosopher 4 is thinking
Philosopher 5 is thinking
Philosopher 3 is hungry
Philosopher 3 takes forks 2 and 3 and starts eating
Philosopher 1 is hungry
Philosopher 1 takes forks 5 and 1 and starts eating
Philosopher 2 is hungry
Philosopher 5 is hungry
Philosopher 4 is hungry
Philosopher 3 puts down forks 2 and 3 and starts thinking
Philosopher 4 takes forks 3 and 4 and starts eating
Philosopher 3 is thinking
Philosopher 1 puts down forks 5 and 1 and starts thinking
Philosopher 2 takes forks 1 and 2 and starts eating
Philosopher 3 is hungry
Philosopher 1 is thinking
Philosopher 1 is hungry
Philosopher 4 puts down forks 3 and 4 and starts thinking
Philosopher 5 takes forks 4 and 5 and starts eating
Philosopher 4 is thinking
Philosopher 2 puts down forks 1 and 2 and starts thinking
Philosopher 3 takes forks 2 and 3 and starts eating
Philosopher 2 is thinking
Philosopher 4 is hungry
Philosopher 2 is hungry
Philosopher 5 puts down forks 4 and 5 and starts thinking
Philosopher 1 takes forks 5 and 1 and starts eating
Philosopher 5 is thinking
Philosopher 3 puts down forks 2 and 3 and starts thinking
Philosopher 4 takes forks 3 and 4 and starts eating
```

Program -5

Question:

Write a C program to simulate:

a) Bankers' algorithm for the purpose of deadlock avoidance.

Code:

```
#include<stdio.h

> int main() { int

n, m, i, j, k;

printf("Enter the number of processes: ");

scanf("%d", &n);

printf("Enter the number of resources:

"); scanf("%d", &m); int

allocation[n][m]; printf("Enter the

Allocation Matrix:\n"); for (i = 0; i < n;

i++){     for (j = 0; j < m; j++){

scanf("%d", &allocation[i][j]);

    }
```

```
} int max[n][m]; printf("Enter the
MAX Matrix:\n"); for (i = 0; i < n;
i++){     for (j = 0; j < m; j++){
scanf("%d", &max[i][j]);
    }
} int
available[m];
printf("Enter the Available
Resources:\n"); for (i = 0; i < m; i++){
scanf("%d", &available[i]);

} int f[n], ans[n], ind = 0; for (k = 0; k <
n; k++){     f[k] = 0; } int need[n][m]; for
(i = 0; i < n; i++){     for (j = 0; j < m;
j++){         need[i][j] = max[i][j] -
allocation[i][j];
    }
} int y = 0; for (k = 0; k < n; k++){
for (i = 0; i < n; i++){         if (f[i] ==
0){             int flag = 0;             for (j
= 0; j < m; j++){                 if
(need[i][j] > available[j]){
flag = 1;                     break;
                }             }             if (flag == 0){
ans[ind++] = i;                 for (y = 0; y < m;
y++){                     available[y] +=
allocation[i][y];
                }
f[i] = 1;
            }
        }
    }
}
```

```
int flag = 1; for (i =
0; i < n; i++){     if
(f[i] == 0){
flag = 0;
        printf("The following system is not safe\n");
break;
    }
}
if (flag == 1){
    printf("Following is the SAFE
Sequence\n");     for (i = 0; i < n - 1; i++){
printf(" P%d ->", ans[i]);
    }
    printf(" P%d\n", ans[n - 1]);
}
return
0;
}
```

Result:

```
* Executing task: C:/Windows/System32/cmd.exe /d /c .\build\Debug\outDebug.exe

Enter the number of processes: 5
Enter the number of resources: 3
Enter the Allocation Matrix:
0 1 0 2 0 0 3 0 2 2 1 1 0 0 2
Enter the MAX Matrix:
7 5 3 3 2 2 9 0 2 2 2 2 4 3 3
Enter the Available Resources:
3 3 2
Following is the SAFE Sequence
 P1 -> P3 -> P4 -> P0 -> P2
* Terminal will be reused by tasks, press any key to close it.
```

Program -6

Question:

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

a) Worst-fit

b) Best-fit

c) First-fit

Code:

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

void firstFit(int blockSize[], int blocks, int processSize[], int processes) {
int allocation[MAX];
    for (int i = 0; i < processes; i++) allocation[i] = -1;


    for (int i = 0; i < processes; i++) {
for (int j = 0; j < blocks; j++) {              if
(blockSize[j] >= processSize[i]) {
allocation[i] = j;
                blockSize[j] -= processSize[i];
break;
            }
        }
    }

    printf("\nFirst-Fit Allocation:\n");
for (int i = 0; i < processes; i++) {
if (allocation[i] != -1)
            printf("Process %d of size %d -> Block %d\n", i + 1, processSize[i], allocation[i] + 1);
else
            printf("Process %d of size %d -> Not Allocated\n", i + 1, processSize[i]);
    }
}

void bestFit(int blockSize[], int blocks, int processSize[], int processes) {
int allocation[MAX];
    for (int i = 0; i < processes; i++) allocation[i] = -1;
```

```
    for (int i = 0; i < processes; i++) {
int best = -1;
        for (int j = 0; j < blocks; j++) {
if (blockSize[j] >= processSize[i]) {
                if (best == -1 || blockSize[j] < blockSize[best]) best = j;
            }
}
        if (best != -1) {
allocation[i] = best;
            blockSize[best] -= processSize[i];
        }
    }

    printf("\nBest-Fit Allocation:\n");
for (int i = 0; i < processes; i++) {
if (allocation[i] != -1)
            printf("Process %d of size %d -> Block %d\n", i + 1, processSize[i], allocation[i] + 1);
else
            printf("Process %d of size %d -> Not Allocated\n", i + 1, processSize[i]);
    }
}

void worstFit(int blockSize[], int blocks, int processSize[], int processes) {
int allocation[MAX];
    for (int i = 0; i < processes; i++) allocation[i] = -1;
    for (int i = 0; i < processes; i++) {
int worst = -1;
        for (int j = 0; j < blocks; j++) {
if (blockSize[j] >= processSize[i]) {
                if (worst == -1 || blockSize[j] > blockSize[worst]) worst = j;
            }
}
```

```
        if (worst != -1) {
allocation[i] = worst;
            blockSize[worst] -= processSize[i];
        }
    }

    printf("\nWorst-Fit Allocation:\n");
for (int i = 0; i < processes; i++) {
if (allocation[i] != -1)
            printf("Process %d of size %d -> Block %d\n", i + 1, processSize[i], allocation[i] + 1);
else
            printf("Process %d of size %d -> Not Allocated\n", i + 1, processSize[i]);
    }
}

int main() {
    int blockSize[MAX], processSize[MAX], blocks, processes, choice;

    printf("Enter number of memory blocks:
");     scanf("%d", &blocks);     printf("Enter
size of each block:\n");     for (int i = 0; i <
blocks; i++) {         printf("Block %d: ", i +
1);         scanf("%d", &blockSize[i]);
    }
    printf("Enter number of processes: ");
scanf("%d", &processes);
printf("Enter size of each process:\n");
for (int i = 0; i < processes; i++) {
printf("Process %d: ", i + 1);
scanf("%d", &processSize[i]);
    }
```

```
    printf("\nMemory Allocation Techniques:\n");     printf("1.
First Fit\n2. Best Fit\n3. Worst Fit\nEnter choice: ");
scanf("%d", &choice);

    int originalBlockSize[MAX];
    for (int i = 0; i < blocks; i++) originalBlockSize[i] = blockSize[i];

    switch (choice) {
case 1:
            firstFit(originalBlockSize,          blocks,          processSize,
processes);             break;         case 2:
            for (int i = 0; i < blocks; i++) blockSize[i] =
originalBlockSize[i];              bestFit(blockSize, blocks, processSize,
processes);             break;         case 3:
            for (int i = 0; i < blocks; i++) blockSize[i] =
originalBlockSize[i];               worstFit(blockSize, blocks, processSize,
processes);             break;         default:
            printf("Invalid choice.\n");
    }

    return 0;
}
```

Result:

```
Enter number of memory blocks: 5
Enter size of each block:
Block 1: 100
Block 2: 500
Block 3: 200
Block 4: 300
Block 5: 600
Enter number of processes: 4
Enter size of each process:
Process 1: 212
Process 2: 417
Process 3: 112
Process 4: 426

Memory Allocation Techniques:
1. First Fit
2. Best Fit
3. Worst Fit
Enter choice: 1

First-Fit Allocation:
Process 1 of size 212 -> Block 2
Process 2 of size 417 -> Block 5
Process 3 of size 112 -> Block 2
Process 4 of size 426 -> Not Allocated
```

```
Enter number of memory blocks: 5
Enter size of each block:
Block 1: 100
Block 2: 500
Block 3: 200
Block 4: 300
Block 5: 600
Enter number of processes: 4
Enter size of each process:
Process 1: 212
Process 2: 417
Process 3: 112
Process 4: 426

Memory Allocation Techniques:
1. First Fit
2. Best Fit
3. Worst Fit
Enter choice: 2

Best-Fit Allocation:
Process 1 of size 212 -> Block 4
Process 2 of size 417 -> Block 2
Process 3 of size 112 -> Block 3
Process 4 of size 426 -> Block 5
```

```
Enter number of memory blocks: 5
Enter size of each block:
Block 1: 100
Block 2: 500
Block 3: 200
Block 4: 300
Block 5: 600
Enter number of processes: 4
Enter size of each process:
Process 1: 212
Process 2: 417
Process 3: 112
Process 4: 426

Memory Allocation Techniques:
1. First Fit
2. Best Fit
3. Worst Fit
Enter choice: 3

Worst-Fit Allocation:
Process 1 of size 212 -> Block 5
Process 2 of size 417 -> Block 2
Process 3 of size 112 -> Block 5
Process 4 of size 426 -> Not Allocated
```

Program -7

Question:

Write a C program to simulate page replacement algorithms.

a) FIFO

b) LRU

c) Optimal

Code:

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

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

    printf("\nFIFO Page
Replacement\n");     for (int i = 0; i < n;
i++) {         int found = 0;         for (int j
= 0; j < capacity; j++) {             if
(frames[j] == pages[i]) {
found = 1;                 break;
            }         }         if (!found) {
frames[index] = pages[i];
index = (index + 1) % capacity;
faults++;
        }

        printf("Frames: ");         for (int
j = 0; j < capacity; j++) {             if
(frames[j] == -1)                 printf(" -
");             else
                printf(" %d ", frames[j]);
        }
printf("\n");
    }
    printf("Total Page Faults: %d\n", faults);
}
```

```
void lru(int pages[], int n, int capacity) {     int
frames[capacity], recent[capacity], faults = 0;

    for (int i = 0; i < capacity; i++) frames[i] = -1;

    printf("\nLRU Page
Replacement\n");     for (int i = 0; i < n;
i++) {         int found = 0;         for (int j
= 0; j < capacity; j++) {             if
(frames[j] == pages[i]) {
recent[j] = i;                 found = 1;
break;
            }
        }

        if (!found) {             int lru_index = 0;             for (int
j = 1; j < capacity; j++) {                 if (frames[j] == -1 ||
recent[j] < recent[lru_index])                     lru_index = j;
            }
            frames[lru_index] = pages[i];
recent[lru_index] = i;
faults++;
        }

        printf("Frames: ");         for (int
j = 0; j < capacity; j++) {             if
(frames[j] == -1)                 printf(" -
");             else                 printf(" %d
", frames[j]);
        }
printf("\n");
    }
    printf("Total Page Faults: %d\n", faults);
```

```
}

void optimal(int pages[], int n, int capacity) {
int frames[capacity], faults = 0;

    for (int i = 0; i < capacity; i++) frames[i] = -1;

    printf("\nOptimal Page
Replacement\n");     for (int i = 0; i < n;
i++) {         int found = 0;         for (int j =
0; j < capacity; j++) {             if (frames[j]
== pages[i]) {                 found = 1;
break;
            }
        }
        if (!found) {             int opt_index
= -1, farthest = i;             for (int j = 0; j
< capacity; j++) {                 if
(frames[j] == -1) {
opt_index = j;                     break;
                }
                int next_use = INT_MAX;
for (int k = i + 1; k < n; k++) {
if (frames[j] == pages[k]) {
next_use = k;                         break;
                    }
                }                 if (next_use
> farthest) {                     farthest
= next_use;
opt_index = j;
                }
            }
```

```
            frames[opt_index] = pages[i];
faults++;
        }

        printf("Frames: ");         for (int
j = 0; j < capacity; j++) {             if
(frames[j] == -1)                printf(" -
");            else                 printf(" %d
", frames[j]);
        }
printf("\n");
    }
    printf("Total Page Faults: %d\n", faults);
}

int main() {
int n, capacity;
    printf("Enter number of pages: ");
scanf("%d", &n);     int pages[n];
    printf("Enter the page reference string: ");
for (int i = 0; i < n; i++) scanf("%d", &pages[i]);
printf("Enter number of frames: ");
scanf("%d", &capacity);

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

    return 0;
}
```

Result:

```
Enter number of pages: 10
Enter the page reference string: 7 0 1 2 0 3 0 4 2 3
Enter number of frames: 3

FIFO Page Replacement
Frames:  7  -  -
Frames:  7  0  -
Frames:  7  0  1
Frames:  2  0  1
Frames:  2  0  1
Frames:  2  3  1
Frames:  2  3  0
Frames:  4  3  0
Frames:  4  2  0
Frames:  4  2  3
Total Page Faults: 9
```

```
LRU Page Replacement
Frames:  -  -  7
Frames:  -  -  0
Frames:  -  -  1
Frames:  -  -  2
Frames:  -  -  0
Frames:  -  -  3
Frames:  -  -  0
Frames:  -  -  4
Frames:  -  -  2
Frames:  -  -  3
Total Page Faults: 10

Optimal Page Replacement
Frames:  7  -  -
Frames:  7  0  -
Frames:  7  0  1
Frames:  2  0  1
Frames:  2  0  1
Frames:  2  0  3
Frames:  2  0  3
Frames:  2  4  3
Frames:  2  4  3
Frames:  2  4  3
Total Page Faults: 6 _
```

Program -8

Write a C program to simulate the following file allocation strategies.

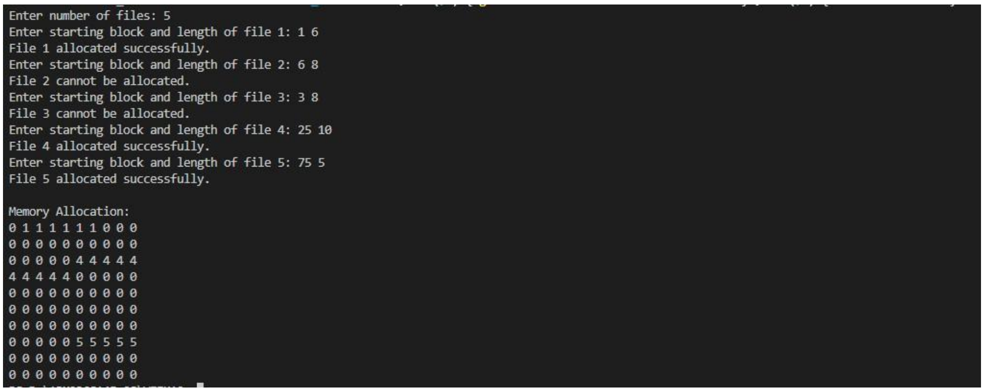
a) Sequential

Code:

```
#include <stdio.h>


int main() {
   int memory[100], i, start, length, j, n;


   for (i = 0; i < 100; i++)
memory[i] = 0;


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


   for (i = 0; i < n; i++) {
       printf("Enter starting block and length of file %d: ", i + 1);
scanf("%d %d", &start, &length);


       int flag = 0;
       for (j = start; j < start + length; j++)
{            if (memory[j] != 0) {
flag = 1;                  break;
           }
       }


       if (flag == 0) {
           for (j = start; j < start + length; j++)
memory[j] = i + 1;
           printf("File %d allocated successfully.\n", i + 1);
       } else {
```

```
            printf("File %d cannot be allocated.\n", i + 1);
        }
    }

    printf("\nMemory
Allocation:\n");     for (i = 0; i <
100; i++) {         printf("%d ",
memory[i]);         if ((i + 1) % 10
== 0)             printf("\n");
    }

    return 0;
}
```

Result:



```
Enter number of files: 5
Enter starting block and length of file 1: 1 6
File 1 allocated successfully.
Enter starting block and length of file 2: 6 8
File 2 cannot be allocated.
Enter starting block and length of file 3: 3 8
File 3 cannot be allocated.
Enter starting block and length of file 4: 25 10
File 4 allocated successfully.
Enter starting block and length of file 5: 75 5
File 5 allocated successfully.

Memory Allocation:
0 1 1 1 1 1 1 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 4 4 4 4 4
4 4 4 4 4 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 5 5 5 5 5
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
```