VISVESVARAYA TECHNOLOGICAL UNIVERSITY
"JnanaSangama", Belgaum -590014, Karnataka.

LAB REPORT
on

OPERATING SYSTEMS

Submitted by

Akshara Singa(1BM22CS029)

in partial fulfillment for the award of the degree of
BACHELOR OF ENGINEERING
in
COMPUTER SCIENCE AND ENGINEERING

B.M.S. COLLEGE OF ENGINEERING
(Autonomous Institution under VTU)
BENGALURU-560019

Apr-2024 to Aug-2024

B. M. S. College of Engineering,
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 **Akshara Singa(1BM22CS029),** 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 2024. 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.

Sneha Bagalkot   **Dr. Jyothi S Nayak**
Assistant Professor   Professor and Head
Department of CSE   Department of CSE
BMSCE, Bengaluru   BMSCE, Bengaluru

Index Sheet

Program -1

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

FCFS

```c
#include <stdio.h>

struct Process {
    int pid;       // Process ID
    int burst_time; // Burst time
    int arrival_time; // Arrival time
    int waiting_time; // Waiting time
    int turnaround_time; // Turnaround time
};

void findWaitingTime(struct Process proc[], int n) {
    int service_time[n];
    service_time[0] = proc[0].arrival_time;
    proc[0].waiting_time = 0;

    for (int i = 1; i < n; i++) {
        service_time[i] = service_time[i-1] + proc[i-1].burst_time;
        proc[i].waiting_time = service_time[i] - proc[i].arrival_time;
        if (proc[i].waiting_time < 0)
            proc[i].waiting_time = 0;
    }
```

```c
    }

    void findTurnaroundTime(struct Process proc[], int n) {

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

            proc[i].turnaround_time = proc[i].burst_time + proc[i].waiting_time;

    }

    void findAverageTime(struct Process proc[], int n) {

        int total_waiting_time = 0, total_turnaround_time = 0;

        findWaitingTime(proc, n);

        findTurnaroundTime(proc, n);

        printf("Processes  Burst time  Arrival time  Waiting time  Turnaround time\n");

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

            total_waiting_time += proc[i].waiting_time;

            total_turnaround_time += proc[i].turnaround_time;

            printf("   %d \t\t%d \t\t%d \t\t%d \t\t%d\n", proc[i].pid, proc[i].burst_time,
    proc[i].arrival_time, proc[i].waiting_time, proc[i].turnaround_time);

        }

        printf("Average waiting time = %.2f\n", (float)total_waiting_time / (float)n);

        printf("Average turnaround time = %.2f\n", (float)total_turnaround_time / (float)n);

    }


    int main() {

        struct Process proc[] = {{1, 10, 0}, {2, 5, 1}, {3, 8, 2}};

        int n = sizeof(proc) / sizeof(proc[0]);
```

```
    findAverageTime(proc, n);



    return 0;

}
```

Output

```
Processes  Burst time  Arrival time  Waiting time  Turnaround time
   1           10            0             0              10
   2           5             1             9              14
   3           8             2             13             21
Average waiting time = 7.33
Average turnaround time = 15.00
```

SJF (pre-emptive)

#include <stdio.h>

struct Process {

    int pid;

    int burst_time;

    int arrival_time;

    int waiting_time;

    int turnaround_time;

};

void findWaitingTime(struct Process proc[], int n) {

    int complete = 0, t = 0, minm = 10000;

    int shortest = 0, finish_time;

```
int check = 0;

int rt[n];

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

  rt[i] = proc[i].burst_time;


while (complete != n) {

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

    if ((proc[j].arrival_time <= t) && (rt[j] < minm) && rt[j] > 0) {

      minm = rt[j];

      shortest = j;

      check = 1;

    }

  }

  if (check == 0) {

    t++;

    continue;

  }

  rt[shortest]--;

  minm = rt[shortest];

  if (minm == 0)

    minm = 10000;

  if (rt[shortest] == 0) {

    complete++;
```

```c
            check = 0;

            finish_time = t + 1;

            proc[shortest].waiting_time = finish_time - proc[shortest].burst_time -
proc[shortest].arrival_time;

            if (proc[shortest].waiting_time < 0)

                proc[shortest].waiting_time = 0;

        }

        t++;

    }

}


void findTurnaroundTime(struct Process proc[], int n) {

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

        proc[i].turnaround_time = proc[i].burst_time + proc[i].waiting_time;

}


void findAverageTime(struct Process proc[], int n) {

    int total_waiting_time = 0, total_turnaround_time = 0;


    findWaitingTime(proc, n);

    findTurnaroundTime(proc, n);


    printf("Processes  Burst time  Arrival time  Waiting time  Turnaround time\n");
```

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

        total_waiting_time += proc[i].waiting_time;

        total_turnaround_time += proc[i].turnaround_time;

        printf("  %d \t\t%d \t\t%d \t\t%d \t\t%d\n", proc[i].pid, proc[i].burst_time,
proc[i].arrival_time, proc[i].waiting_time, proc[i].turnaround_time);

    }


    printf("Average waiting time = %.2f\n", (float)total_waiting_time / (float)n);

    printf("Average turnaround time = %.2f\n", (float)total_turnaround_time / (float)n);

}


int main() {
    struct Process proc[] = {{1, 6, 0}, {2, 8, 1}, {3, 7, 2}, {4, 3, 3}};

    int n = sizeof(proc) / sizeof(proc[0]);


    findAverageTime(proc, n);


    return 0;
}
```

OUTPUT

```
Processes   Burst time   Arrival time   Waiting time   Turnaround time
   1             6             0              0                6
   2             8             1             15               23
   3             7             2              7               14
   4             3             3              3                6
Average waiting time = 6.25
Average turnaround time = 12.25
```

Program-2

Write a C program to simulate the following CPU scheduling to find turnaround time and waiting time.

Priority (pre-emptive)

```c
#include <stdio.h>

struct Process {

    int pid;

    int burst_time;

    int arrival_time;

    int priority;

    int waiting_time;

    int turnaround_time;

};


void findWaitingTime(struct Process proc[], int n) {

    int rt[n];

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

        rt[i] = proc[i].burst_time;


    int complete = 0, t = 0, minm = 10000;

    int shortest = 0, finish_time;

    int check = 0;


    while (complete != n) {
```

```c
    for (int j = 0; j < n; j++) {

        if ((proc[j].arrival_time <= t) && (proc[j].priority < minm) && rt[j] > 0) {

            minm = proc[j].priority;

            shortest = j;

            check = 1;

        }

    }

    if (check == 0) {

        t++;

        continue;

    }

    rt[shortest]--;

    minm = proc[shortest].priority;

    if (rt[shortest] == 0) {

        complete++;

        check = 0;

        finish_time = t + 1;

        proc[shortest].waiting_time = finish_time - proc[shortest].burst_time - proc[shortest].arrival_time;

        if (proc[shortest].waiting_time < 0)

            proc[shortest].waiting_time = 0;

        minm = 10000;

    }

    t++;
```

```c
        }

    }


    void findTurnaroundTime(struct Process proc[], int n) {

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

            proc[i].turnaround_time = proc[i].burst_time + proc[i].waiting_time;

    }


    void findAverageTime(struct Process proc[], int n) {

        int total_waiting_time = 0, total_turnaround_time = 0;


        findWaitingTime(proc, n);

        findTurnaroundTime(proc, n);


        printf("Processes  Burst time  Arrival time  Priority  Waiting time  Turnaround time\n");


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

            total_waiting_time += proc[i].waiting_time;

            total_turnaround_time += proc[i].turnaround_time;

            printf("   %d \t\t%d \t\t%d \t\t%d \t\t%d \t\t%d\n", proc[i].pid, proc[i].burst_time,
proc[i].arrival_time, proc[i].priority, proc[i].waiting_time, proc[i].turnaround_time);

        }


        printf("Average waiting time = %.2f\n", (float)total_waiting_time / (float)n);
```

```c
    printf("Average turnaround time = %.2f\n", (float)total_turnaround_time / (float)n);

}



int main() {

    struct Process proc[] = {{1, 6, 0, 2}, {2, 8, 1, 1}, {3, 7, 2, 3}, {4, 3, 3, 2}};

    int n = sizeof(proc) / sizeof(proc[0]);



    findAverageTime(proc, n);



    return 0;

}
```

```
Processes   Burst time   Arrival time   Priority   Waiting time   Turnaround time
   1             6             0             2             2             8             14
   2             8             1             1             0             8
   3             7             2             3             15             22
   4             3             3             2             11             14
Average waiting time = 8.50
Average turnaround time = 14.50
```

Program 3

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

```c
#include <stdio.h>


struct Process {
    int pid;
    int burst_time;
    int arrival_time;
    int priority;
    int waiting_time;
    int turnaround_time;
};


void findWaitingTime(struct Process proc[], int n) {
    int completed[n];
    for (int i = 0; i < n; i++)
        completed[i] = 0;


    int t = 0;
    int completed_count = 0;
```

```
    while (completed_count < n) {

        int min_priority = 10000;

        int idx = -1;

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

            if (proc[i].arrival_time <= t && !completed[i] && proc[i].priority < min_priority) {

                min_priority = proc[i].priority;

                idx = i;

            }

        }


        if (idx != -1) {

            t += proc[idx].burst_time;

            proc[idx].waiting_time = t - proc[idx].burst_time - proc[idx].arrival_time;

            if (proc[idx].waiting_time < 0)

                proc[idx].waiting_time = 0;

            completed[idx] = 1;

            completed_count++;

        } else {

            t++;

        }

    }

}
```

```c
void findTurnaroundTime(struct Process proc[], int n) {

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

        proc[i].turnaround_time = proc[i].burst_time + proc[i].waiting_time;

}


void findAverageTime(struct Process proc[], int n) {

    int total_waiting_time = 0, total_turnaround_time = 0;


    findWaitingTime(proc, n);

    findTurnaroundTime(proc, n);


    printf("Processes  Burst time  Arrival time  Priority  Waiting time  Turnaround time\n");


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

        total_waiting_time += proc[i].waiting_time;

        total_turnaround_time += proc[i].turnaround_time;

        printf("   %d \t\t%d \t\t%d \t\t%d \t\t%d \t\t%d\n", proc[i].pid, proc[i].burst_time,
proc[i].arrival_time, proc[i].priority, proc[i].waiting_time, proc[i].turnaround_time);

    }


    printf("Average waiting time = %.2f\n", (float)total_waiting_time / (float)n);

    printf("Average turnaround time = %.2f\n", (float)total_turnaround_time / (float)n);

}
```

```
int main() {

    struct Process proc[] = {{1, 6, 0, 2}, {2, 8, 1, 1}, {3, 7, 2, 3}, {4, 3, 3, 2}};

    int n = sizeof(proc) / sizeof(proc[0]);


    findAverageTime(proc, n);


    return 0;

}
```



```
Robin.c -o RoundRobin } ; if ($?) { .\RoundRobin }
Enter the Number of Processes: 3

Enter the quantum time: 2

Enter the process: 1
Enter the Burst Time:4

Enter the process: 2
Enter the Burst Time:3

Enter the process: 3
Enter the Burst Time:5


Processes        Burst Time        Waiting Time        turnaround time

    1               4                 4                    8

    2               3                 6                    9

    3               5                 7                    12

Average waiting time = 5.666667
Average turnaround time = 9.666667
```

Program 4

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

Rate- Monotonic

```c
#include <stdio.h>

void findWaitingTime(int processes[], int n, int bt[], int wt[], int period[]) {
    wt[0] = 0;
    for (int i = 1; i < n; i++) {
        wt[i] = bt[i - 1] + wt[i - 1];
    }
}

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

void findAvgTime(int processes[], int n, int bt[], int period[]) {
    int wt[n], tat[n];
    findWaitingTime(processes, n, bt, wt, period);
    findTurnAroundTime(processes, n, bt, wt, tat);

    printf("Processes   Burst time   Waiting time   Turnaround time   Period\n");
    for (int i = 0; i < n; i++) {
        printf(" %d ", (i + 1));
        printf("        %d ", bt[i]);
        printf("        %d ", wt[i]);
```

```c
        printf("        %d ", tat[i]);

        printf("            %d\n", period[i]);

    }

    int total_wt = 0, total_tat = 0;

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

        total_wt += wt[i];

        total_tat += tat[i];

    }

    printf("Average waiting time = %.2f\n", (float)total_wt / (float)n);

    printf("Average turnaround time = %.2f\n", (float)total_tat / (float)n);

}

void rateMonotonicScheduling(int processes[], int n, int bt[], int period[]) {

    // Sort by period

    for (int i = 0; i < n - 1; i++) {

        for (int j = 0; j < n - i - 1; j++) {

            if (period[j] > period[j + 1]) {

                int temp = period[j];

                period[j] = period[j + 1];

                period[j + 1] = temp;

                temp = bt[j];

                bt[j] = bt[j + 1];

                bt[j + 1] = temp;

                temp = processes[j];

                processes[j] = processes[j + 1];

                processes[j + 1] = temp;

            }

        }
```

```c
    }

  findAvgTime(processes, n, bt, period);

}


int main() {

    int processes[] = {1, 2, 3};

    int n = sizeof(processes) / sizeof(processes[0]);

    int burst_time[] = {3, 1, 2};

    int period[] = {7, 4, 5};


    rateMonotonicScheduling(processes, n, burst_time, period);

    return 0;

}
```

```
Processes   Burst time   Waiting time   Turnaround time   Period
1           1            0              1                 4
2           2            1              3                 5
3           3            3              6                 7
Average waiting time = 1.33
Average turnaround time = 3.33
```

Earliest-deadline First

```c
#include <stdio.h>


void findWaitingTime(int processes[], int n, int bt[], int wt[], int deadline[]) {

    wt[0] = 0;

    for (int i = 1; i < n; i++) {

        wt[i] = bt[i - 1] + wt[i - 1];
```

```c
    }
}


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


void findAvgTime(int processes[], int n, int bt[], int deadline[]) {
  int wt[n], tat[n];
  findWaitingTime(processes, n, bt, wt, deadline);
  findTurnAroundTime(processes, n, bt, wt, tat);

  printf("Processes   Burst time   Waiting time   Turnaround time   Deadline\n");
  for (int i = 0; i < n; i++) {
    printf(" %d ", (i + 1));
    printf("        %d ", bt[i]);
    printf("        %d ", wt[i]);
    printf("        %d ", tat[i]);
    printf("          %d\n", deadline[i]);
  }

  int total_wt = 0, total_tat = 0;
  for (int i = 0; i < n; i++) {
    total_wt += wt[i];
    total_tat += tat[i];
```

```c
    }

    printf("Average waiting time = %.2f\n", (float)total_wt / (float)n);

    printf("Average turnaround time = %.2f\n", (float)total_tat / (float)n);

}


void earliestDeadlineFirstScheduling(int processes[], int n, int bt[], int deadline[]) {

    // Sort by deadline

    for (int i = 0; i < n - 1; i++) {

        for (int j = 0; j < n - i - 1; j++) {

            if (deadline[j] > deadline[j + 1]) {

                int temp = deadline[j];

                deadline[j] = deadline[j + 1];

                deadline[j + 1] = temp;

                temp = bt[j];

                bt[j] = bt[j + 1];

                bt[j + 1] = temp;

                temp = processes[j];

                processes[j] = processes[j + 1];

                processes[j + 1] = temp;

            }

        }

    }


    findAvgTime(processes, n, bt, deadline);

}
```

```c
int main() {

    int processes[] = {1, 2, 3};

    int n = sizeof(processes) / sizeof(processes[0]);

    int burst_time[] = {3, 1, 2};

    int deadline[] = {7, 4, 5};


    earliestDeadlineFirstScheduling(processes, n, burst_time, deadline);

    return 0;

}
```

```
Processes    Burst time    Waiting time    Turnaround time    Ratio
1                3              0                3               0.50
2                2              3                5               0.30
3                1              5                6               0.20
Average waiting time = 2.67
Average turnaround time = 4.67
```

Program 5

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

```c
#include <stdio.h>

#include <stdlib.h>

#include <pthread.h>

#include <semaphore.h>

#define BUFFER_SIZE 5

int buffer[BUFFER_SIZE];

int in = 0, out = 0;

sem_t empty;

sem_t full;

pthread_mutex_t mutex;

void *producer(void *param) {
    int item;
    while (1) {
        item = rand() % 100;
        sem_wait(&empty);
        pthread_mutex_lock(&mutex);

        buffer[in] = item;
        printf("Producer produced %d at %d\n", item, in);
        in = (in + 1) % BUFFER_SIZE;
```

```c
        pthread_mutex_unlock(&mutex);

        sem_post(&full);

        sleep(1);

    }

}


void *consumer(void *param) {

    int item;

    while (1) {

        sem_wait(&full);

        pthread_mutex_lock(&mutex);


        item = buffer[out];

        printf("Consumer consumed %d from %d\n", item, out);

        out = (out + 1) % BUFFER_SIZE;


        pthread_mutex_unlock(&mutex);

        sem_post(&empty);

        sleep(1);

    }

}


int main() {

    pthread_t tid1, tid2;

    pthread_attr_t attr;
```

```
    pthread_attr_init(&attr);

    pthread_mutex_init(&mutex, NULL);

    sem_init(&empty, 0, BUFFER_SIZE);

    sem_init(&full, 0, 0);


    pthread_create(&tid1, &attr, producer, NULL);

    pthread_create(&tid2, &attr, consumer, NULL);


    pthread_join(tid1, NULL);

    pthread_join(tid2, NULL);


    pthread_mutex_destroy(&mutex);

    sem_destroy(&empty);

    sem_destroy(&full);


    return 0;

}
```

```
|              ^~~~~
Producer produced 83 at 0
Consumer consumed 83 from 0
Producer produced 86 at 1
Consumer consumed 86 from 1
Producer produced 77 at 2
Consumer consumed 77 from 2
Producer produced 15 at 3
Consumer consumed 15 from 3
Producer produced 93 at 4
Consumer consumed 93 from 4
Producer produced 35 at 0
Consumer consumed 35 from 0
Producer produced 86 at 1
Consumer consumed 86 from 1
Producer produced 92 at 2
Consumer consumed 92 from 2
Producer produced 49 at 3
Consumer consumed 49 from 3
Producer produced 21 at 4
Consumer consumed 21 from 4
Producer produced 62 at 0
Consumer consumed 62 from 0
Producer produced 27 at 1
Consumer consumed 27 from 1
Producer produced 90 at 2
Consumer consumed 90 from 2
```

Program 6

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

```c
#include <stdio.h>

#include <stdlib.h>

#include <pthread.h>

#include <semaphore.h>

#define N

sem_t forks[N];

sem_t mutex;

void *philosopher(void *num) {
    int id = *(int *)num;
    while (1) {
        printf("Philosopher %d is thinking.\n", id);
        sleep(1);

        sem_wait(&mutex);
        sem_wait(&forks[id]);
        sem_wait(&forks[(id + 1) % N]);

        printf("Philosopher %d is eating.\n", id);
        sleep(1);

        sem_post(&forks[id]); // Put down chopsticks
```

```c
        sem_post(&forks[(id + 1) % N]);

        sem_post(&mutex);


        printf("Philosopher %d is done eating and starts thinking again.\n", id);

        sleep(1);

    }

}


int main() {

    pthread_t tid[N];

    int ids[N];


    sem_init(&mutex, 0, 1);


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

        sem_init(&forks[i], 0, 1);

        ids[i] = i;

    }


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

        pthread_create(&tid[i], NULL, philosopher, &ids[i]);

    }


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

        pthread_join(tid[i], NULL);

    }
```

```
   for (int i = 0; i < N; i++) {

      sem_destroy(&forks[i]);

   }

   sem_destroy(&mutex);


   return 0;

}
```

```
Philosopher 0 is thinking.
Philosopher 1 is thinking.
Philosopher 2 is thinking.
Philosopher 3 is thinking.
Philosopher 4 is thinking.
Philosopher 0 is eating.
Philosopher 0 is done eating and starts thinking again.
Philosopher 1 is eating.
Philosopher 0 is thinking.
Philosopher 1 is done eating and starts thinking again.
Philosopher 2 is eating.
Philosopher 3 is eating.
Philosopher 2 is done eating and starts thinking again.
Philosopher 1 is thinking.
Philosopher 2 is thinking.
Philosopher 4 is eating.
Philosopher 3 is done eating and starts thinking again.
Philosopher 3 is thinking.
Philosopher 0 is eating.
Philosopher 4 is done eating and starts thinking again.
Philosopher 4 is thinking.
Philosopher 1 is eating.
Philosopher 0 is done eating and starts thinking again.
Philosopher 1 is done eating and starts thinking again.
Philosopher 2 is eating.
Philosopher 0 is thinking.
Philosopher 2 is done eating and starts thinking again.
Philosopher 1 is thinking.
Philosopher 3 is eating.
Philosopher 2 is thinking.
Philosopher 4 is eating.
Philosopher 3 is done eating and starts thinking again.
```

Program 7

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

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

#define MAX_PROCESSES 5
#define MAX_RESOURCES 3

int main() {
  int n, m, i, j, k;
  n = 5;
  m = 3;

  int alloc[MAX_PROCESSES][MAX_RESOURCES] = { { 0, 1, 0 },
                    { 2, 0, 0 },
                    { 3, 0, 2 },
                    { 2, 1, 1 },
                    { 0, 0, 2 } };

  int max[MAX_PROCESSES][MAX_RESOURCES] = { { 7, 5, 3 },
                    { 3, 2, 2 },
                    { 9, 0, 2 },
                    { 2, 2, 2 },
                    { 4, 3, 3 } };
```

```c
int avail[MAX_RESOURCES] = { 3, 3, 2 };

int f[MAX_PROCESSES], ans[MAX_PROCESSES], ind = 0;

for (k = 0; k < n; k++) {

    f[k] = 0;

}


int need[MAX_PROCESSES][MAX_RESOURCES];

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

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

        need[i][j] = max[i][j] - alloc[i][j];

    }

}

printf("Need matrix:\n");

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

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

        printf("%d ", need[i][j]);

    }

    printf("\n");

}

int y = 0;

for (k = 0; k < n; k++) {

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

        if (f[i] == 0) {

            bool flag = true;

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

                if (need[i][j] > avail[j]) {

                    flag = false;
```

```c
                break;
            }  }
        if (flag) {
            ans[ind++] = i;
            for (y = 0; y < m; y++) {
                avail[y] += alloc[i][y];
            }
            f[i] = 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;
}
```

```
Need matrix:
7 4 3
1 2 2
6 0 0
0 1 1
4 3 1
Following is the SAFE Sequence:
 P1 -> P3 -> P4 -> P0 -> P2
```

Program 8

Write a C program to simulate deadlock detection

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

#define MAX_PROCESSES 5
#define MAX_RESOURCES 3

void printMatrices(int processes, int resources, int alloc[MAX_PROCESSES][MAX_RESOURCES],
int max[MAX_PROCESSES][MAX_RESOURCES], int need[MAX_PROCESSES][MAX_RESOURCES],
int avail[MAX_RESOURCES]) {
  printf("Allocation Matrix:\n");
  for (int i = 0; i < processes; i++) {
    for (int j = 0; j < resources; j++) {
      printf("%d ", alloc[i][j]);
    }
    printf("\n");
  }

  printf("\nMax Matrix:\n");
  for (int i = 0; i < processes; i++) {
    for (int j = 0; j < resources; j++) {
      printf("%d ", max[i][j]);
    }
    printf("\n");
  }
```

```c
    printf("\nNeed Matrix:\n");

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

        for (int j = 0; j < resources; j++) {

            printf("%d ", need[i][j]);

        }

        printf("\n");

    }


    printf("\nAvailable Resources:\n");

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

        printf("%d ", avail[i]);

    }

    printf("\n");

}


void deadlockDetection(int processes, int resources, int
alloc[MAX_PROCESSES][MAX_RESOURCES], int max[MAX_PROCESSES][MAX_RESOURCES], int
avail[MAX_RESOURCES]) {

    int need[MAX_PROCESSES][MAX_RESOURCES];

    int work[MAX_RESOURCES];

    bool finish[MAX_PROCESSES];


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

        for (int j = 0; j < resources; j++) {

            need[i][j] = max[i][j] - alloc[i][j];

        }

    }
```

```c
printMatrices(processes, resources, alloc, max, need, avail);
for (int i = 0; i < resources; i++) {
    work[i] = avail[i];
}
for (int i = 0; i < processes; i++) {
    finish[i] = false;
}
bool found;
do {
    found = false;
    for (int i = 0; i < processes; i++) {
        if (!finish[i]) {
            bool flag = true;
            for (int j = 0; j < resources; j++) {
                if (need[i][j] > work[j]) {
                    flag = false;
                    break;
                }
            }

            if (flag) {
                printf("\nProcess %d can be satisfied and is now finishing.\n", i);
                for (int k = 0; k < resources; k++) {
                    work[k] += alloc[i][k];
                }
                finish[i] = true;
                found = true;
```

```c
            printf("New Available Resources:\n");

            for (int k = 0; k < resources; k++) {

                printf("%d ", work[k]);

            }

            printf("\n");

          }

        }

      }

    } while (found);

    bool deadlock = false;

    printf("\nDeadlock Check:\n");

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

      if (!finish[i]) {

        deadlock = true;

        printf("Process %d is in a deadlock.\n", i);

      }

    }

    if (!deadlock) {

      printf("No deadlock detected.\n");

    }

}

int main() {

   int processes = 5;

   int resources = 3;


   int alloc[MAX_PROCESSES][MAX_RESOURCES] = {
```

```
    { 0, 1, 0 },

    { 2, 0, 0 },

    { 3, 0, 2 },

    { 2, 1, 1 },

    { 0, 0, 2 }

  };

  int max[MAX_PROCESSES][MAX_RESOURCES] = {

    { 7, 5, 3 },

    { 3, 2, 2 },

    { 9, 0, 2 },

    { 2, 2, 2 },

    { 4, 3, 3 }

  };

  int avail[MAX_RESOURCES] = { 3, 3, 2 }; // Available resources

  deadlockDetection(processes, resources, alloc, max, avail);

  return 0;

}
```

```
Allocation Matrix:
0 1 0
2 0 0
3 0 2
2 1 1
0 0 2

Max Matrix:
7 5 3
3 2 2
9 0 2
2 2 2
4 3 3

Need Matrix:
7 4 3
1 2 2
6 0 0
0 1 1
4 3 1

Available Resources:
3 3 2
```

```
Process 1 can be satisfied and is now finishing.
New Available Resources:
5 3 2

Process 3 can be satisfied and is now finishing.
New Available Resources:
7 4 3

Process 4 can be satisfied and is now finishing.
New Available Resources:
7 4 5

Process 0 can be satisfied and is now finishing.
New Available Resources:
7 5 5

Process 2 can be satisfied and is now finishing.
New Available Resources:
10 5 7

Deadlock Check:
No deadlock detected.
```

Program 9

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

a) Worst-fit

b) Best-fit

c) First-fit

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

#define MAX 25

void firstFit(int nb, int nf, int b[], int f[]) {
    int allocation[MAX];
    int allocated[MAX] = {0};
    for (int i = 0; i < nf; i++) {
        allocation[i] = -1;
        for (int j = 0; j < nb; j++) {
            if (allocated[j] == 0 && b[j] >= f[i]) {
                allocation[i] = j;
                allocated[j] = 1;
                break;
            }
        }
    }

    printf("\nFile_no:\tFile_size:\tBlock_no:\tBlock_size:");
```

```c
    for (int i = 0; i < nf; i++) {

        if (allocation[i] != -1)

            printf("\n%d\t\t%d\t\t%d\t\t%d", i + 1, f[i], allocation[i] + 1, b[allocation[i]]);

        else

            printf("\n%d\t\t%d\t\t-\t\t-", i + 1, f[i]);

    }

}


void bestFit(int nb, int nf, int b[], int f[]) {

    int allocation[MAX];

    int allocated[MAX] = {0};

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

        int bestIdx = -1;

        allocation[i] = -1;

        for (int j = 0; j < nb; j++) {

            if (allocated[j] == 0 && b[j] >= f[i]) {

                if (bestIdx == -1 || b[j] < b[bestIdx])

                    bestIdx = j;

            }

        }

        if (bestIdx != -1) {

            allocation[i] = bestIdx;

            allocated[bestIdx] = 1;

        }

    }


    printf("\nFile_no:\tFile_size:\tBlock_no:\tBlock_size:");
```

```c
    for (int i = 0; i < nf; i++) {

        if (allocation[i] != -1)

            printf("\n%d\t\t%d\t\t%d\t\t%d", i + 1, f[i], allocation[i] + 1, b[allocation[i]]);

        else

            printf("\n%d\t\t%d\t\t-\t\t-", i + 1, f[i]);

    }

}


void worstFit(int nb, int nf, int b[], int f[]) {

    int allocation[MAX];

    int allocated[MAX] = {0};


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

        int worstIdx = -1;

        allocation[i] = -1;

        for (int j = 0; j < nb; j++) {

            if (allocated[j] == 0 && b[j] >= f[i]) {

                if (worstIdx == -1 || b[j] > b[worstIdx])

                    worstIdx = j;

            }

        }

        if (worstIdx != -1) {

            allocation[i] = worstIdx;

            allocated[worstIdx] = 1;

        }

    }
```

```c
    printf("\nFile_no:\tFile_size:\tBlock_no:\tBlock_size:");
    for (int i = 0; i < nf; i++) {
        if (allocation[i] != -1)
            printf("\n%d\t\t%d\t\t%d\t\t%d", i + 1, f[i], allocation[i] + 1, b[allocation[i]]);
        else
            printf("\n%d\t\t%d\t\t-\t\t-", i + 1, f[i]);
    }
}


int main() {
    int nb, nf, choice;

    printf("Memory Management Scheme");
    printf("\nEnter the number of blocks: ");
    scanf("%d", &nb);
    printf("Enter the number of files: ");
    scanf("%d", &nf);
    int b[nb], f[nf];
    printf("\nEnter the size of the blocks:\n");
    for (int i = 0; i < nb; i++) {
        printf("Block %d: ", i + 1);
        scanf("%d", &b[i]);
    }
    printf("Enter the size of the files:\n");
    for (int i = 0; i < nf; i++) {
        printf("File %d: ", i + 1);
        scanf("%d", &f[i]);
```

```c
      }

      while (1) {
          printf("\n1. First Fit\n2. Best Fit\n3. Worst Fit\n4. Exit\n");
          printf("Enter your choice: ");
          scanf("%d", &choice);
          switch (choice) {
              case 1:
                  printf("\n\tMemory Management Scheme - First Fit\n");
                  firstFit(nb, nf, b, f);
                  break;
              case 2:
                  printf("\n\tMemory Management Scheme - Best Fit\n");
                  bestFit(nb, nf, b, f);
                  break;
              case 3:
                  printf("\n\tMemory Management Scheme - Worst Fit\n");
                  worstFit(nb, nf, b, f);
                  break;
              case 4:
                  printf("\nExiting...\n");
                  exit(0);
                  break;
              default:
                  printf("\nInvalid choice.\n");
                  break;
          }
```

```
    }


    return 0;

}
```

```
Memory Management Scheme
Enter the number of blocks: 5
Enter the number of files: 4

Enter the size of the blocks:
Block 1: 100
Block 2: 500
Block 3: 200
Block 4: 300
Block 5: 600
Enter the size of the files:
File 1: 212
File 2: 417
File 3: 112
File 4: 426
```

```
1. First Fit
2. Best Fit
3. Worst Fit
4. Exit
Enter your choice: 1

        Memory Management Scheme - First Fit

File_no:          File_size:       Block_no:        Block_size:
1                 212              2                500
2                 417              5                600
3                 112              3                200
4                 426              -                -
1. First Fit
2. Best Fit
3. Worst Fit
4. Exit
Enter your choice: 2

        Memory Management Scheme - Best Fit

File_no:          File_size:       Block_no:        Block_size:
1                 212              4                300
2                 417              2                500
3                 112              3                200
4                 426              5                600
1. First Fit
2. Best Fit
3. Worst Fit
4. Exit
Enter your choice: 3

        Memory Management Scheme - Worst Fit

File_no:          File_size:       Block_no:        Block_size:
1                 212              5                600
2                 417              2                500
3                 112              4                300
4                 426              -                -
1. First Fit
2. Best Fit
3. Worst Fit
4. Exit
Enter your choice:
```

Program 10

Write a C program to simulate page replacement algorithms

a) FIFO

b) LRU

c) Optimal

```c
#include <stdio.h>

#include <stdlib.h>

#include <stdbool.h>


#define MAX_FRAMES 10

#define MAX_PAGES 25


void fifo(int pages[], int n, int capacity) {

    int frame[MAX_FRAMES], frameCount = 0, pageFaults = 0, frameIndex = 0;

    bool isPagePresent = false;


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

        isPagePresent = false;

        for (int j = 0; j < frameCount; j++) {

            if (frame[j] == pages[i]) {

                isPagePresent = true;

                break;

            }

        }
```

```c
        if (isPagePresent == false) {

            if (frameCount < capacity) {

                frame[frameCount] = pages[i];

                frameCount++;

            } else {

                frame[frameIndex] = pages[i];

                frameIndex++;

                if (frameIndex >= capacity)

                    frameIndex = 0;

            }

            pageFaults++;

        }

    }

    printf("\nFIFO Page Replacement Algorithm:\n");

    printf("Total Page Faults: %d\n", pageFaults);

}


void lru(int pages[], int n, int capacity) {

    int frame[MAX_FRAMES], frameCount = 0, pageFaults = 0, counter[MAX_FRAMES];

    bool isPagePresent = false;


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

        isPagePresent = false;

        for (int j = 0; j < frameCount; j++) {

            if (frame[j] == pages[i]) {

                isPagePresent = true;

                counter[j] = i;
```

```
          break;

        }

      }


      if (isPagePresent == false) {

        if (frameCount < capacity) {

          frame[frameCount] = pages[i];

          counter[frameCount] = i;

          frameCount++;

        } else {

          int lru = 0;

          for (int j = 1; j < capacity; j++) {

            if (counter[j] < counter[lru])

              lru = j;

          }

          frame[lru] = pages[i];

          counter[lru] = i;

        }

        pageFaults++;

      }

    }

    printf("\nLRU Page Replacement Algorithm:\n");

    printf("Total Page Faults: %d\n", pageFaults);

}


void optimal(int pages[], int n, int capacity) {

    int frame[MAX_FRAMES], frameCount = 0, pageFaults = 0;
```

```cpp
    bool isPagePresent = false;


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

    isPagePresent = false;

    for (int j = 0; j < frameCount; j++) {

        if (frame[j] == pages[i]) {

            isPagePresent = true;

            break;

        }

    }


    if (isPagePresent == false) {

        if (frameCount < capacity) {

            frame[frameCount] = pages[i];

            frameCount++;

        } else {

            int future[MAX_FRAMES] = {0};

            for (int j = 0; j < frameCount; j++) {

                bool isFound = false;

                for (int k = i + 1; k < n; k++) {

                    if (pages[k] == frame[j]) {

                        future[j] = k;

                        isFound = true;

                        break;

                    }

                }

                if (isFound == false)
```

```c
            future[j] = n + 1;
        }
        int longest = 0;
        for (int j = 1; j < frameCount; j++) {
            if (future[j] > future[longest])
                longest = j;
        }
        frame[longest] = pages[i];
    }
    pageFaults++;
    }
  }
  printf("\nOptimal Page Replacement Algorithm:\n");
  printf("Total Page Faults: %d\n", pageFaults);
}


int main() {
  int pages[MAX_PAGES], n, capacity;

  printf("Page Replacement Algorithms\n");
  printf("Enter the number of pages: ");
  scanf("%d", &n);
  printf("Enter the page reference string:\n");
  for (int i = 0; i < n; i++) {
    printf("Page %d: ", i + 1);
    scanf("%d", &pages[i]);
  }
```

```
    printf("Enter the number of frames: ");

    scanf("%d", &capacity);


    fifo(pages, n, capacity);

    lru(pages, n, capacity);

    optimal(pages, n, capacity);


    return 0;

}
```

```
Page Replacement Algorithms
Enter the number of pages: 10
Enter the page reference string:
Page 1: 1
Page 2: 2
Page 3: 1
Page 4: 4
Page 5: 6
Page 6: 4
Page 7: 2
Page 8: 1
Page 9: 56
Page 10: 3
Enter the number of frames: 3

FIFO Page Replacement Algorithm:
Total Page Faults: 7

LRU Page Replacement Algorithm:
Total Page Faults: 8

Optimal Page Replacement Algorithm:
Total Page Faults: 7
```

Write a C program to simulate disk scheduling algorithms:

(a) FCFS

(b) SCAN

(c) c-SCAN

(a) FCFS:

```c
#include<stdio.h>

#include<stdlib.h>

int main()

{

int RQ[100],i,n,TotalHeadMoment=0,initial;

printf("Enter the number of Requests\n");

scanf("%d",&n);

printf("Enter the Requests sequence\n");

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

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

printf("Enter initial head position\n");

scanf("%d",&initial);

// logic for FCFS disk scheduling

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

{

TotalHeadMoment=TotalHeadMoment+abs(RQ[i]-initial);

initial=RQ[i];

}

printf("Total head moment is %d",TotalHeadMoment);

return 0;

}
```

```
Enter the number of Requests
8
Enter the Requests sequence
98 183 37 122 14 124 65 67
Enter initial head position
53
Total head moment is 640
```

(b) SCAN:

#include<stdio.h>

#include<stdlib.h>

int main()

{

int RQ[100],i,j,n,TotalHeadMoment=0,initial,size,move;

printf("Enter the number of Requests\n");

scanf("%d",&n);

printf("Enter the Requests sequence\n");

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

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

printf("Enter initial head position\n");

scanf("%d",&initial);

printf("Enter total disk size\n");

scanf("%d",&size);

printf("Enter the head movement direction for high 1 and for low 0\n");

scanf("%d",&move);

// logic for Scan disk scheduling

/*logic for sort the request array */

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

```
{

for(j=0;j<n-i-1;j++)

{

if(RQ[j]>RQ[j+1])

{

int temp;

temp=RQ[j];

RQ[j]=RQ[j+1];

RQ[j+1]=temp;

}

}

}

int index;

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

{

if(initial<RQ[i])

{

index=i;

break;

}

}

//if movement is towards high value

if(move==1)

{

for(i=index;i<n;i++)

{

TotalHeadMoment=TotalHeadMoment+abs(RQ[i]-initial);
```

```
initial=RQ[i];

}

// last movement for max size

TotalHeadMoment=TotalHeadMoment+abs(size-RQ[i-1]-1);

initial = size-1;

for(i=index-1;i>=0;i--)

{

TotalHeadMoment=TotalHeadMoment+abs(RQ[i]-initial);

initial=RQ[i];

}

}

// if movement is towards low value

else

{

for(i=index-1;i>=0;i--)

{

TotalHeadMoment=TotalHeadMoment+abs(RQ[i]-initial);

initial=RQ[i];

}

// last movement for min size

TotalHeadMoment=TotalHeadMoment+abs(RQ[i+1]-0);

initial =0;

for(i=index;i<n;i++)

{

TotalHeadMoment=TotalHeadMoment+abs(RQ[i]-initial);

initial=RQ[i];
```

```
}
}
printf("Total head movement is %d",TotalHeadMoment);
return 0;
}
```

```
Enter the number of Requests
8
Enter the Requests sequence
98 183 37 122 14 124 65 67
Enter initial head position
53
Enter total disk size
199
Enter the head movement direction for high 1 and for low 0
0
Total head movement is 236
```

(c) c-SCAN:

```
#include<stdio.h>
#include<stdlib.h>
int main()
{
int RQ[100],i,j,n,TotalHeadMoment=0,initial,size,move;
printf("Enter the number of Requests\n");
scanf("%d",&n);
printf("Enter the Requests sequence\n");

for(i=0;i<n;i++)
scanf("%d",&RQ[i]);
printf("Enter initial head position\n");
```

```c
scanf("%d",&initial);

printf("Enter total disk size\n");

scanf("%d",&size);

printf("Enter the head movement direction for high 1 and for low 0\n");

scanf("%d",&move);

// logic for C-Scan disk scheduling

/*logic for sort the request array */

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

{

for( j=0;j<n-i-1;j++)

{

if(RQ[j]>RQ[j+1])

{

int temp;

temp=RQ[j];

RQ[j]=RQ[j+1];

RQ[j+1]=temp;

}

}

}

int index;

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

{

if(initial<RQ[i])

{

index=i;

break;
```

```
}

}

// if movement is towards high value

if(move==1)

{

for(i=index;i<n;i++)

{

TotalHeadMoment=TotalHeadMoment+abs(RQ[i]-initial);


initial=RQ[i];

}

// last movement for max size

TotalHeadMoment=TotalHeadMoment+abs(size-RQ[i-1]-1);

/*movement max to min disk */

TotalHeadMoment=TotalHeadMoment+abs(size-1-0);

initial=0;

for( i=0;i<index;i++)

{

TotalHeadMoment=TotalHeadMoment+abs(RQ[i]-initial);

initial=RQ[i];

}

}

// if movement is towards low value

else

{

for(i=index-1;i>=0;i--)

{
```

```c
TotalHeadMoment=TotalHeadMoment+abs(RQ[i]-initial);

initial=RQ[i];

}

// last movement for min size

TotalHeadMoment=TotalHeadMoment+abs(RQ[i+1]-0);

/*movement min to max disk */

TotalHeadMoment=TotalHeadMoment+abs(size-1-0);

initial =size-1;

for(i=n-1;i>=index;i--)

{

TotalHeadMoment=TotalHeadMoment+abs(RQ[i]-initial);

initial=RQ[i];

}

}

printf("Total head movement is %d",TotalHeadMoment);

return 0;

}
```

```
Enter the number of Requests
8
Enter the Requests sequence
98 183 37 122 14 124 65 67
Enter initial head position
53
Enter total disk size
199
Enter the head movement direction for high 1 and for low 0
0
Total head movement is 384
```