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# Operating System Lab Manual

**Experiment No-1:**

**Aim: Practicing of Basic UNIX Commands.**

1 a.)Study of Unix/Linux general purpose utility command list: man,who,cat, cd,

cp, ps, ls, mv, rm, mkdir, rmdir, echo, more, date, time, kill, history, chmod, chown,

finger, pwd, cal, logout, shutdown.

list of Unix/Linux general-purpose utility commands you mentioned one by one:

1. man: Short for &quot;manual,&quot; the man command is used to display the manual or documentation

for other commands. It provides detailed information on how to use a specific command, its

options, and usage examples.

2. who: The who command displays a list of currently logged-in users on the system, along

with information about their login sessions.

3. cat: The cat command is used to concatenate and display the content of one or multiple

files. It is also frequently used to create and edit files directly in the terminal.

4. cd: The cd command is used to change the current working directory in the terminal. It

allows you to navigate through the directory structure of the file system.

5. cp: The cp command is used to copy files and directories from one location to another.

6. ps: The ps command stands for &quot;processstatus&quot; and is used to display information about the currently running processes on the system.

7. ls: The ls command lists the contents of a directory, showing files and subdirectories in the specified location.

8. mv: The mv command is used to move or rename files and directories.

9. rm: The rm command is used to remove (delete) files and directories. Be cautious when using this command, as it is not easily reversible.

10. mkdir: The mkdir command is used to create new directories (folders) in the file system.

11. rmdir: The rmdir command is used to remove empty directories (folders) from the file system.

12. echo: The echo command is used to display a message or text on the terminal. It is also frequently used in shell scripting.

13. more: The more command is used to display the content of a file one screen at a time, allowing you to scroll through it.

14. date: The date command displays the current date and time.

15. time: The time command is used to measure the execution time of other commands.

16. kill: The kill command is used to terminate or send signals to running processes. It is commonly used to end processes gracefully or forcefully.

17. history: The history command displays a list of previously executed commands in the current session.

18. chmod: The chmod command is used to change the permissions (read, write, execute) of files and directories.

19. chown: The chown command is used to change the ownership of files and directories, assigning them to different users or groups.

20. finger: The finger command is used to display information about user accounts on thesystem.

21. pwd: The pwd command stands for &quot;print working directory,&quot; and it displays the full path ofthe current working directory.

22. cal: The cal command displays the calendar for the specified month or year.

23. logout: The logout command is used to log out from the current user session in the

terminal.

24. shutdown: The shutdown command is used to shut down or restart the system.

**Experiment No-2:**

**Aim: Write programs using the following UNIX operating system calls**

**A. open, read, write, seek and close**

**Source code :**

```
#include <stdio.h>

#include <conio.h> // for getch()

int main() {

FILE *file;

char buffer[100];

file = fopen("testfile.txt", "w+"); // "w+" creates a file for reading and writing

if (file == NULL) {

printf("Error opening/creating file.\n");

return 1;

}

fprintf(file, "Hello, Students");

fseek(file, 0, SEEK_SET);

fgets(buffer, 100, file);

printf("Content read from file: %s\n", buffer);
```

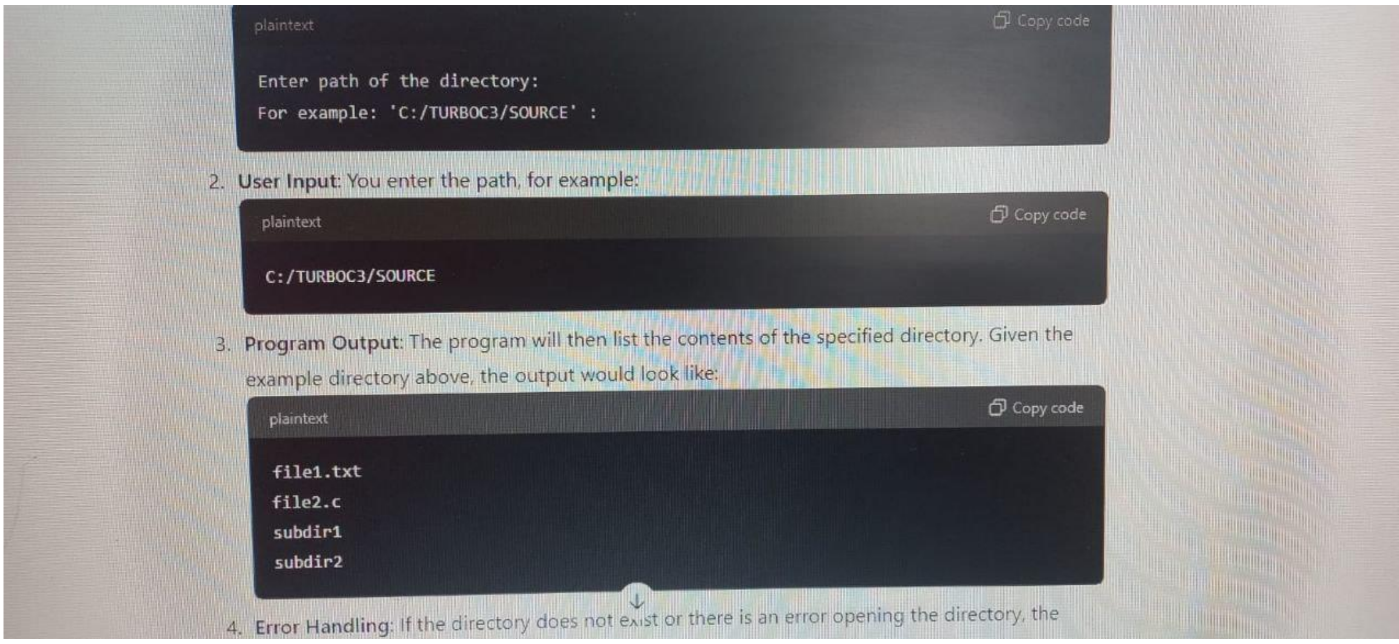
fclose(file);

getch(); // Wait for key press before exiting (specific to Turbo C++)

return 0;

}

Output:



```
plaintext
Enter path of the directory:
For example: 'C:/TURBOC3/SOURCE' :
```

2. **User Input**: You enter the path, for example:

```
plaintext
C:/TURBOC3/SOURCE
```

3. **Program Output**: The program will then list the contents of the specified directory. Given the example directory above, the output would look like:

```
plaintext
file1.txt
file2.c
subdir1
subdir2
```

4. **Error Handling**: If the directory does not exist or there is an error opening the directory, the

**B. opendir, closedir**

**Source code :**

```
#include <stdio.h>

#include <stdlib.h>

#include <dirent.h>

#include<conio.h>

int main(void) {

   DIR *d;
```

```
    struct dirent *dir;

    char *directory_path = " "; // "." refers to the current directory

    clrscr();

      printf("\nEnter path of the directory...!\n");

    printf("\For example: 'C:/TURBOC3/SOURCE' :\n");

    scanf("%s",directory_path);

    d = opendir(directory_path);

    if (d) {

        while ((dir = readdir(d)) != NULL) {

            printf("%s\n", dir->d_name);

        }

        closedir(d);

    } else {

          perror("Unable to open directory");

        return EXIT_FAILURE;

    }

    getch();

    return EXIT_SUCCESS;

}
```

**Output:**

```
C:/TURBOC3/Sourcedir1

file1.txt

file2.c

subdir1

program.exe
```

```
C:/TURBOC3/Sourcedir2

Unable to open directory: No such file or directory
```

**Experiment No-3:**

**AIM:**

**To write C programs to simulate UNIX commands like cp, ls, grep.**

**1. Program for simulation of cp unix commands**

**Source code :**

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

int main(int argc, char *argv[]) {
    FILE *source, *destination;
    char ch;

   if (argc != 3) {
printf("Usage: ./cp_simulation<source_file><destination_file>\n");
        return 1;
    }
   source = fopen(argv[1], "r");
    if (source == NULL) {
printf("Unable to open source file: %s\n", argv[1]);
        return 1;
    }

    destination = fopen(argv[2], "w");
    if (destination == NULL) {
printf("Unable to open or create destination file: %s\n", argv[2]);
fclose(source);
        return 1;
    }

       while ((ch = fgetc(source)) != EOF) {
fputc(ch, destination);
    }
fclose(source);
fclose(destination);

printf("File copied successfully.\n");

    return 0;
}
```

**Output**: ./cp_simulation source.txt destination.txt

```
File copied successfully.
```

2. Program for simulation of ls unix commands

**Source code :**

```
#include<stdio.h>

#include<dirent.h>

main(intargc,char**argv)

{

DIR*dp;

struct dirent *link;
dp=opendir(argv[1]);

printf("\ncontentsofthedirectory%sare\n",argv[1]); while((link=readdir(dp))!=0)
```

```
    printf("%s",link->d_name);
closedir(dp);

    }
```

**Output:** ./list_directoryexample_dir

```
contents of the directory example_dir are

.

..

file1.txt

file2.txt

subdir1

subdir2
```

## 3.**Program for simulation of grep unix commands**

**Source code :**

```
#include<stdio.h>
#include<string.h>
#define max 1024
void usage()
{
printf("usage:\t. /a.out filename word \n ");
}
int main(int argc, char *argv[])
{
FILE *fp;
char fline[max]; char *newline; int count=0;
int occurrences=0; if(argc!=3)
{
usage();
exit(1);
}
if(!(fp=fopen(argv[1],"r")))
{
printf("grep: couldnot open file : %s \n",argv[1]);
exit(1);
}
while(fgets(fline,max,fp)!=NULL)
{
count++; if(newline=strchr(fline, „\n‟))
*newline=‟\0‟;
if(strstr(fline,argv[2])!=NULL)
{
printf("%s: %d %s \n", argv[1],count, fline);
occurrences++;
}
}
}
```

Input and Output:

Suppose you have a text file named example.txt with the following content:

```
Hello world!
This is a test file.
The word "test" appears twice in this test file.
This is the last line.
```

```
Input: ./search_word example.txt test
Output: example.txt: 2 This is a test file.
example.txt: 3 The word "test" appears twice in this test file.
```

**Experiment 4:**

**Aim: Simulate the following CPU scheduling algorithms:**

**(a) Round Robin (b) SJF (c) FCFS (d) Priority**

**A) Round Robin CPU SCHEDULING ALGORITHM**

**PROGRAM:**

**Source code :**

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

```
int main()
{
int st[10],bt[10],wt[10],tat[10],n,tq;
int i,count=0,swt=0,stat=0,temp,sq=0;
float awt=0.0,atat=0.0;
printf("Enter number of processes:");
scanf("%d",&n);
printf("Enter burst time for sequences:");
for(i=0;i<n;i++)
{
scanf("%d",&bt[i]);
st[i]=bt[i];
}
printf("Enter time quantum:");
scanf("%d",&tq);
while(1)
{
for(i=0,count=0;i<n;i++)
{
temp=tq;
if(st[i]==0)
{
count++;
continue;
}
if(st[i]>tq)
st[i]=st[i]-tq;
else
if(st[i]>=0)
{
temp=st[i];
st[i]=0;
}
sq=sq+temp;
tat[i]=sq;
}
if(n==count)
break;
}
for(i=0;i<n;i++)
{
wt[i]=tat[i]-bt[i];
swt=swt+wt[i];
stat=stat+tat[i];
}
awt=(float)swt/n;
atat=(float)stat/n;
printf("Process_no Burst time Wait time Turn around time");
for(i=0;i<n;i++)
printf("\n%d\t %d\t %d\t %d",i+1,bt[i],wt[i],tat[i]);
printf("\nAvg wait time is %f Avgturn around time is %f",awt,atat);
return 0;
}
```

INPUT:

```
Enter number of processes:3
Enter burst time for sequences:12
8
20
Enter time quantum:5
```

EXPECTED OUT PUT:

```
Process_no Burst time Wait time Turn around time
1 12 18 30
2 8 15 23
3 20 20 40
Avg wait time is 17.666666 Avgturn around time is 31.000000
```

## B)SJF CPU SCHEDULING ALGORITHM

**PROGRAM:**

**Source code :**

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

```
int main()
{
int i,j,bt[10],t,n,wt[10],tt[10],w1=0,t1=0;
float aw,at;
printf("enter no. of processes:\n");
scanf("%d",&n);
printf("enter the burst time of processes:");
for(i=0;i<n;i++)
scanf("%d",&bt[i]);
for(i=0;i<n;i++)
{
for(j=i;j<n;j++)
if(bt[i]>bt[j])
{
t=bt[i];
bt[i]=bt[j];
bt[j]=t;
}
}
for(i=0;i<n;i++)
printf("%d",bt[i]);
for(i=0;i<n;i++)
{
wt[0]=0;
tt[0]=bt[0];
wt[i+1]=bt[i]+wt[i];
tt[i+1]=tt[i]+bt[i+1];
w1=w1+wt[i];
t1=t1+tt[i];
}
aw=w1/n;
at=t1/n;
printf("\nbt\t wt\t tt\n");
for(i=0;i<n;i++)
printf("%d\t %d\t %d\n",bt[i],wt[i],tt[i]);
printf("aw=%f\n,at=%f\n",aw,at);
return 0;
}
```

INPUT:

```
enter no. of processes:
3
enter the burst time of processes:12
8
20
```

EXPECTED OUT PUT

```
8 12 20
btwttt
8 0 8
12 8 20
20 20 40
aw=9.000000
,at=22.000000
```

## C) FCFS CPU SCHEDULING ALGORITHM

**PROGRAM:**

**Source code:**

```
#include<stdio.h>
int main()
{
int i,j,bt[10],n,wt[10],tt[10],w1=0,t1=0;
float aw,at;
printf("enter no. of processes:\n");
scanf("%d",&n);
printf("enter the burst time of processes:");
for(i=0;i<n;i++)
scanf("%d",&bt[i]);
for(i=0;i<n;i++)
{
wt[0]=0;
tt[0]=bt[0];
wt[i+1]=bt[i]+wt[i];
tt[i+1]=tt[i]+bt[i+1];
w1=w1+wt[i];
t1=t1+tt[i];
}
aw=w1/n;
at=t1/n;
printf("\nbt\t wt\t tt\n");
for(i=0;i<n;i++)
printf("%d\t %d\t %d\n",bt[i],wt[i],tt[i]);
printf("aw=%f\n,at=%f\n",aw,at);
return 0;
}
```

INPUT:

```
enter no. of processes:
3
enter the burst time of processes:12
8
20
```

EXPECTED OUTPUT:

```
btwttt
12 0 12
8 12 20
20 20 40
aw=10.000000
,at=24.000000
```

## D) Priority based CPU SCHEDULING ALGORITHM

**PROGRAM:**

**Source code :**

```
#include<stdio.h>
int main()
{
int i,j,pno[10],prior[10],bt[10],n,wt[10],tt[10],w1=0,t1=0,s;
float aw,at;
printf("enter the number of processes:");
scanf("%d",&n);
```

```
for(i=0;i<n;i++)
{
printf("The process %d:\n",i+1);
printf("Enter the burst time of processes:");
scanf("%d",&bt[i]);
printf("Enter the priority of processes %d:",i+1);
scanf("%d",&prior[i]);
pno[i]=i+1;
}
for(i=0;i<n;i++)
{
for(j=0;j<n;j++)
{
if(prior[i]<prior[j])
{
s=prior[i];
prior[i]=prior[j];
prior[j]=s;
s=bt[i];
bt[i]=bt[j];
bt[j]=s;
s=pno[i];
pno[i]=pno[j];
pno[j]=s;
}
}
}
for(i=0;i<n;i++)
{
wt[0]=0;
tt[0]=bt[0];
wt[i+1]=bt[i]+wt[i];
tt[i+1]=tt[i]+bt[i+1];
w1=w1+wt[i];
t1=t1+tt[i];
aw=w1/n;
at=t1/n;
}
printf(" \n job \t bt \t wt \t tat \t prior\n");
for(i=0;i<n;i++)
printf("%d \t %d \t %d\t %d\t %d\n",pno[i],bt[i],wt[i],tt[i],prior[i]);
printf("aw=%f \t at=%f \n",aw,at);
return 0;
}
```

INPUT:

```
enter the number of processes:3
The process 1:
Enter the burst time of processes:12
Enter the priority of processes 1:3
The process 2:
Enter the burst time of processes:8
Enter the priority of processes 2:2
The process 3:
Enter the burst time of processes:20
Enter the priority of processes 3:1
```

EXPECTED OUTPUT:

```
job btwt tat prior
3 20 0 20 1
2 8 20 28 2
1 12 28 40 3
aw=16.000000 at=29.000000
```

## Experiment 5:

**Aim: Control the number of ports opened by the operating system with**

a. **Semaphore**
b. **Monitor**

A. Semaphore

```
#include <stdio.h>

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

```
#include <semaphore.h>
#include <unistd.h>

#define MAX_PORTS 3
sem_tsemaphore;
void* open_port(void* arg) {
    int port_number = *((int*)arg);
printf("Thread %d waiting to open a port...\n", port_number);


sem_wait(&semaphore);

printf("Thread %d opened a port.\n", port_number);
sleep(2);

printf("Thread %d closed the port.\n", port_number);

sem_post(&semaphore);

    free(arg);
    return NULL;
}

int main() {
    sem_init(&semaphore, 0, MAX_PORTS);

pthread_tthreads[5];

       for (int i = 0; i< 5; i++) {
        int* port_number = malloc(sizeof(int));
        *port_number = i + 1;
pthread_create(&threads[i], NULL, open_port, port_number);
    }

       for (int i = 0; i< 5; i++) {
pthread_join(threads[i], NULL);
    }
sem_destroy(&semaphore);

    return 0;
}
```

**Output:**

```
Thread 1 waiting to open a port...
Thread 1 opened a port.
Thread 2 waiting to open a port...
Thread 2 opened a port.
Thread 3 waiting to open a port...
Thread 3 opened a port.
Thread 4 waiting to open a port...
Thread 5 waiting to open a port...
Thread 1 closed the port.
Thread 4 opened a port.
Thread 2 closed the port.
Thread 5 opened a port.
Thread 3 closed the port.
Thread 4 closed the port.
Thread 5 closed the port.
```

## B. Monitors

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

#define MAX_PORTS 3

int open_ports = 0;
pthread_mutex_tmutex;
pthread_cond_tcond;
```

```
void* open_port(void* arg) {
    int port_number = *((int*)arg);
printf("Thread %d waiting to open a port...\n", port_number);

pthread_mutex_lock(&mutex);

    while (open_ports>= MAX_PORTS) {
printf("Thread %d is waiting since all ports are busy.\n", port_number);
pthread_cond_wait(&cond, &mutex);  // Block this thread until the condition is met
    }

    open_ports++;
printf("Thread %d opened a port. Currently opened ports: %d\n", port_number, open_ports);

pthread_mutex_unlock(&mutex);

sleep(2);
pthread_mutex_lock(&mutex);

open_ports--;
printf("Thread %d closed the port. Currently opened ports: %d\n", port_number, open_ports);

    pthread_cond_signal(&cond);

pthread_mutex_unlock(&mutex);

    free(arg);
    return NULL;
}

int main() {
pthread_tthreads[5];
pthread_mutex_init(&mutex, NULL);
pthread_cond_init(&cond, NULL);

    for (int i = 0; i< 5; i++) {
        int* port_number = malloc(sizeof(int));
        *port_number = i + 1;
pthread_create(&threads[i], NULL, open_port, port_number);
    }

   for (int i = 0; i< 5; i++) {
pthread_join(threads[i], NULL);
    }

    pthread_mutex_destroy(&mutex);
pthread_cond_destroy(&cond);

    return 0;
}
```

**Output:**

```
Thread 1 waiting to open a port...
Thread 1 opened a port. Currently opened ports: 1
Thread 2 waiting to open a port...
Thread 2 opened a port. Currently opened ports: 2
Thread 3 waiting to open a port...
Thread 3 opened a port. Currently opened ports: 3
Thread 4 waiting to open a port...
Thread 4 is waiting since all ports are busy.
Thread 5 waiting to open a port...
Thread 5 is waiting since all ports are busy.
Thread 1 closed the port. Currently opened ports: 2
Thread 4 opened a port. Currently opened ports: 3
Thread 2 closed the port. Currently opened ports: 2
Thread 5 opened a port. Currently opened ports: 3
Thread 3 closed the port. Currently opened ports: 2
Thread 4 closed the port. Currently opened ports: 1
Thread 5 closed the port. Currently opened ports: 0
```

## Experiment No-6:

**AIM: Write a program to illustrate concurrent execution of threads using pthreads library.**

**SOURCE CODE :**

```
#include <stdio.h>
#include <stdlib.h>
#include <pthread.h>
#include <unistd.h>
#define NUM_THREADS 5
void* print_thread_info(void* threadid) {
    long tid;
    tid = (long)threadid;
    printf("Thread %ld: Starting...\n", tid);
    sleep(1);
    printf("Thread %ld: Exiting...\n", tid);
    pthread_exit(NULL);
}
int main() {
    pthread_t threads[NUM_THREADS];
    int rc;
    long t;

    for (t = 0; t < NUM_THREADS; t++) {
        printf("Main: Creating thread %ld\n", t);
        rc = pthread_create(&threads[t], NULL, print_thread_info, (void*)t);
        if (rc) {
            printf("Error: Unable to create thread %ld, %d\n", t, rc);
            exit(-1);
        }
    }

    for (t = 0; t < NUM_THREADS; t++) {
        pthread_join(threads[t], NULL);
    }
    printf("Main: All threads completed.\n");
    pthread_exit(NULL);
}
```

**OUT PUT:**

```
Main: creating thread 0
Main: creating thread 1
Main: creating thread 2
Main: creating thread 3
Main: creating thread 4
Thread 0 is starting...
Thread 1 is starting...
Thread 2 is starting...
Thread 3 is starting...
Thread 4 is starting...
Thread 0 is finishing...
Thread 1 is finishing...
Thread 2 is finishing...
Thread 3 is finishing...
Thread 4 is finishing...
All threads have completed.
```

## Experiment No-7:

**AIM: Write a program to solve producer-consumer problem using Semaphores.**

**SOURCE CODE :**

```
#include <stdio.h>
#include <stdlib.h>
#include <pthread.h>
#include <semaphore.h>
#include <unistd.h>
#define BUFFER_SIZE 5
int buffer[BUFFER_SIZE];
int count = 0;
```

```
sem_t empty;
sem_t full;
pthread_mutex_t mutex;
void* producer(void* arg) {
    int item;
    while (1) {
        item = rand() % 100;
        sem_wait(&empty);
        pthread_mutex_lock(&mutex);
        buffer[count] = item;
        count++;
        printf("Produced: %d. Buffer count: %d\n", item, count);
        pthread_mutex_unlock(&mutex);
        sem_post(&full);
        sleep(rand() % 2);  // Sleep for a random time
    }
}
void* consumer(void* arg) {
    int item;
    while (1) {
        sem_wait(&full);
                pthread_mutex_lock(&mutex);
        count--;
        item = buffer[count];
        printf("Consumed: %d. Buffer count: %d\n", item, count);
        pthread_mutex_unlock(&mutex);
        sem_post(&empty);
        sleep(rand() % 2);
    }
}
int main() {
    pthread_t prod[3], cons[3];
    sem_init(&empty, 0, BUFFER_SIZE);
    sem_init(&full, 0, 0);
    pthread_mutex_init(&mutex, NULL);
    for (int i = 0; i < 3; i++) {
        pthread_create(&prod[i], NULL, producer, NULL);
    }
        for (int i = 0; i < 3; i++) {
        pthread_create(&cons[i], NULL, consumer, NULL);
    }
        for (int i = 0; i < 3; i++) {
        pthread_join(prod[i], NULL);
        pthread_join(cons[i], NULL);
    }
      sem_destroy(&empty);
    sem_destroy(&full);
    pthread_mutex_destroy(&mutex);
    return 0;
}
```

**OUT PUT :**

```
Producer 1 produced: 12
Producer 1 produced: 34
Producer 2 produced: 45
Consumer 1 consumed: 12
Consumer 2 consumed: 34
Producer 1 produced: 23
Consumer 1 consumed: 45
Producer 2 produced: 67
Consumer 2 consumed: 23
Consumer 1 consumed: 67
Producer 1 produced: 89
Producer 2 produced: 10
Consumer 2 consumed: 89
Consumer 1 consumed: 10
Producer 1 produced: 5
Producer 2 produced: 39
Consumer 2 consumed: 5
Consumer 1 consumed: 39
```

**Experiment No-8:**

**AIM : Implement the following memory allocation methods for fixed partition a) First fit b) Worst fit c) Best fit**

**First Fit Memory Allocation Source Code:**

**Source code :**

```
#include <stdio.h>
void firstFit(int blocks[]
, int m,
 int processes[],
 int n) {
    int allocation[n];
    for (int i = 0; i< n; i++) {
        allocation[i] = -1;
    }
    for (int i = 0; i< n; i++) {
        for (int j = 0; j < m; j++) {
            if (blocks[j] >= processes[i]) {
                allocation[i] = j;
                blocks[j] -= processes[i];
                break;
            }
        }
    }
printf("First Fit Allocation:\n");
```

```
    for (int i = 0; i< n; i++) {
        if (allocation[i] != -1)
printf("Process %d allocated to Block %d\n", i + 1, allocation[i] + 1);
        else
printf("Process %d not allocated\n", i + 1);
    }
}
int main() {
    int blocks[] = {100, 500, 200, 300, 600};
    int processes[] = {212, 417, 112, 426};
    int m = sizeof(blocks) / sizeof(blocks[0]);
    int n = sizeof(processes) / sizeof(processes[0]);
firstFit(blocks, m, processes, n);
    return 0;
}
```

**OUTPUT:**

```
First Fit Allocation:
Process 1 allocated to Block 2
Process 2 allocated to Block 5
Process 3 allocated to Block 2
Process 4 not allocated
```

## B .Best Fit Memory Allocation Source code:

## Source code:

```
#include <stdio.h>
void bestFit(int blocks[], int m, int processes[], int n) {
    int allocation[n];
    for (int i = 0; i< n; i++) {
        allocation[i] = -1; // Initialize allocation array
    }

    for (int i = 0; i< n; i++) {
        int bestIdx = -1;
        for (int j = 0; j < m; j++) {
            if (blocks[j] >= processes[i]) {
                if (bestIdx == -1 || blocks[j] < blocks[bestIdx]) {
bestIdx = j; // Select the smallest block that fits
                }
            }
        }

        if (bestIdx != -1) {
            allocation[i] = bestIdx;
            blocks[bestIdx] -= processes[i];
        }
    }

printf("Best Fit Allocation:\n");
    for (int i = 0; i< n; i++) {
        if (allocation[i] != -1)
printf("Process %d allocated to Block %d\n", i + 1, allocation[i] + 1);
        else
printf("Process %d not allocated\n", i + 1);
    }
}

int main() {
    int blocks[] = {100, 500, 200, 300, 600}; // Memory blocks
    int processes[] = {212, 417, 112, 426};   // Processes requiring memory
    int m = sizeof(blocks) / sizeof(blocks[0]);
    int n = sizeof(processes) / sizeof(processes[0]);

bestFit(blocks, m, processes, n);
```

```
    return 0;
}
```

**Output:**

```
Best Fit Allocation:
Process 1 allocated to Block 4
Process 2 allocated to Block 2
Process 3 allocated to Block 3
Process 4   allocated to Block 5
```

## C. Worst Fit Memory Allocation Source Code:

**Source code:**

```
#include <stdio.h>
void worstFit(int blocks[], int m, int processes[], int n) {
    int allocation[n];
    for (int i = 0; i< n; i++) {
        allocation[i] = -1; // Initialize allocation array
    }

    for (int i = 0; i< n; i++) {
        int worstIdx = -1;
        for (int j = 0; j < m; j++) {
            if (blocks[j] >= processes[i]) {
                if (worstIdx == -1 || blocks[j] > blocks[worstIdx]) {
worstIdx = j; // Select the largest block that fits
                }
            }
        }

        if (worstIdx != -1) {
            allocation[i] = worstIdx;
            blocks[worstIdx] -= processes[i];
        }
    }

printf("Worst Fit Allocation:\n");
    for (int i = 0; i< n; i++) {
        if (allocation[i] != -1)
printf("Process %d allocated to Block %d\n", i + 1, allocation[i] + 1);
        else
printf("Process %d not allocated\n", i + 1);
    }
}
```

```
int main() {
    int blocks[] = {100, 500, 200, 300, 600}; // Memory blocks
    int processes[] = {212, 417, 112, 426};   // Processes requiring memory
    int m = sizeof(blocks) / sizeof(blocks[0]);
    int n = sizeof(processes) / sizeof(processes[0]);

worstFit(blocks, m, processes, n);

    return 0;
}
```

**Output:**

```
Worst Fit Allocation:
Process 1 allocated to Block 5
Process 2 allocated to Block 2
Process 3 allocated to Block 5
Process 4 not allocated
```

**Experiment No-9:**

**AIM Simulate the following page replacement algorithms a) FIFO b) LRU c) LFU**

a) **FIFO Source Code:**
   **Source code:**

```
#include <stdio.h>

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

    int frames[capacity];

    int front = 0, page_faults = 0;

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

        frames[i] = -1;

printf("FIFO Page Replacement:\n");

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

        int page = pages[i];

        int flag = 0;

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

            if (frames[j] == page) {

                flag = 1;  // Page found, no fault

break;

            }

        }

        if (flag == 0) {
            frames[front] = page;
            front = (front + 1) % capacity;
page_faults++;
printf("Page %d caused a page fault.\n", page);
        }
printf("Frames: [");
        for (int j = 0; j < capacity; j++) {
            if (frames[j] != -1) {
printf("%d ", frames[j]);
            } else {
printf("- ");
            }
        }
printf("]\n");
    }
printf("Total Page Faults: %d\n\n", page_faults);
}

int main() {
    int pages[] = {1, 3, 0, 3, 5, 6, 3, 1, 6, 3};
    int n = sizeof(pages) / sizeof(pages[0]);
    int capacity = 3;
fifoPageReplacement(pages, n, capacity);
    return 0;
}
```

**Output :**

```
Page 1 caused a page fault.
Frames: [1 - - ]
Page 3 caused a page fault.
Frames: [1 3 - ]
Page 0 caused a page fault.
Frames: [1 3 0 ]
```

```
Frames: [1 3 0 ]
Page 5 caused a page fault.
Frames: [5 3 0 ]
Page 6 caused a page fault.
Frames: [5 6 0 ]
Frames: [5 6 0 ]
Frames: [5 6 0 ]
Frames: [5 6 0 ]
Total Page Faults: 5
```

**b) LRU Source Code:**
**Source code :**

```
 #include <stdio.h>
 void lruPageReplacement(int pages[],
 int n,
 int capacity)
{
 int frames[capacity], counter[capacity], time = 0;
 int page_faults = 0;
 for (int i = 0; i< capacity; i++) {
     frames[i] = -1;
     counter[i] = 0;
 }
printf("LRU Page Replacement:\n");
 for (int i = 0; i< n; i++) {
     int page = pages[i];
     int flag = 0, least = 0;
             for (int j = 0; j < capacity; j++) {
         if (frames[j] == page) {
             flag = 1;  // Page found, no fault
             counter[j] = ++time;  // Update time for LRU
break;
```

```
            }
        }
        if (flag == 0) {  // Page fault occurred
            for (int j = 1; j < capacity; j++) {
                if (counter[j] < counter[least]) {
                    least = j;
                }
            }
            frames[least] = page;  // Replace the least recently used page
            counter[least] = ++time;  // Update time
page_faults++;
printf("Page %d caused a page fault.\n", page);
        }
        printf("Frames: [");
        for (int j = 0; j < capacity; j++) {
            if (frames[j] != -1) {
printf("%d ", frames[j]);
            } else {
printf("- ");
            }
        }
printf("]\n");
    }
printf("Total Page Faults: %d\n\n", page_faults);
}
int main() {
    int pages[] = {1, 3, 0, 3, 5, 6, 3, 1, 6, 3};
    int n = sizeof(pages) / sizeof(pages[0]);
    int capacity = 3;
lruPageReplacement(pages, n, capacity);
    return 0;
}
```

**OUTPUT:**

```
Page 1 caused a page fault.
Frames: [1 - - ]
Page 3 caused a page fault.
Frames: [1 3 - ]
Page 0 caused a page fault.
Frames: [1 3 0 ]
Frames: [1 3 0 ]
Page 5 caused a page fault.
Frames: [5 3 0 ]
Page 6 caused a page fault.
Frames: [5 6 0 ]
Frames: [5 6 0 ]
Frames: [5 6 0 ]
Frames: [5 6 0 ]
Total Page Faults: 5
```

**c)LFU Source Code:**

**Source code :**

```
   #include <stdio.h>
   void lfuPageReplacement(int pages[],
   int n,
   int capacity)
 {
   int frames[capacity], frequency[capacity], page_faults = 0;
      for (int i = 0; i< capacity; i++) {
      frames[i] = -1;
      frequency[i] = 0;
   }
printf("LFU Page Replacement:\n");
   for (int i = 0; i< n; i++) {
      int page = pages[i];
```

```
        int flag = 0, least = 0;
        for (int j = 0; j < capacity; j++) {
            if (frames[j] == page) {
                flag = 1;  // Page found, no fault
                frequency[j]++;  // Increase frequency of the page
break;
            }
        }
        if (flag == 0) {  // Page fault occurred
                    for (int j = 1; j < capacity; j++) {
                if (frequency[j] < frequency[least]) {
                    least = j;
                }
            }
            frames[least] = page;  // Replace the least frequently used page
            frequency[least] = 1;  // Reset the frequency for the new page
page_faults++;
printf("Page %d caused a page fault.\n", page);
        }
printf("Frames: [");
        for (int j = 0; j < capacity; j++) {
            if (frames[j] != -1) {
printf("%d ", frames[j]);
            } else {
printf("- ");
            }
        }
printf("]\n");
    }
printf("Total Page Faults: %d\n\n", page_faults);
}
int main() {
    int pages[] = {1, 3, 0, 3, 5, 6, 3, 1, 6, 3};
    int n = sizeof(pages) / sizeof(pages[0]);
    int capacity = 3;
lfuPageReplacement(pages, n, capacity);
    return 0;
}
```

**Output:**

```
Page 1 caused a page fault.
Frames: [1 - - ]
Page 3 caused a page fault.
Frames: [1 3 - ]
Page 0 caused a page fault.
Frames: [1 3 0 ]
Frames: [1 3 0 ]
Page 5 caused a page fault.
Frames: [5 3 0 ]
Page 6 caused a page fault.
Frames: [5 6 0 ]
Frames: [5 6 0 ]
Frames: [5 6 0 ]
Frames: [5 6 0 ]
Total Page Faults: 5
```

## Experiment No: 10

## Aim: Simulate Paging Technique of memory management.

## Source Code:

```
#include <stdio.h>
#include <stdlib.h>
#define PAGE_SIZE 4
#define MEMORY_SIZE 16
#define NUM_PAGES MEMORY_SIZE / PAGE_SIZE
int main() {
    int logical_address, page_number, offset, physical_address;
    int page_table[NUM_PAGES];
        for (int i = 0; i < NUM_PAGES; i++) {
        page_table[i] = i;
    }
    printf("PAGE TABLE:\n");
    printf("Page Number -> Frame Number\n");
    for (int i = 0; i < NUM_PAGES; i++) {
        printf("     %d      ->      %d\n", i, page_table[i]);
    }
    printf("\nEnter a logical address (0 to %d): ", MEMORY_SIZE - 1);
    scanf("%d", &logical_address);
        if (logical_address < 0 || logical_address >= MEMORY_SIZE) {
        printf("Invalid logical address! Please enter an address between 0 and %d.\n", MEMORY_SIZE
- 1);
        return 1;
    }
    page_number = logical_address / PAGE_SIZE;
    offset = logical_address % PAGE_SIZE;
    physical_address = (page_table[page_number] * PAGE_SIZE) + offset;
        printf("\nLogical Address: %d\n", logical_address);
    printf("Page Number: %d, Offset: %d\n", page_number, offset);
    printf("Physical Address: %d (Frame Number: %d, Offset: %d)\n", physical_address,
page_table[page_number], offset);


    return 0;
}
```

**Output:**

```
PAGE TABLE:
Page Number -> Frame Number
     0      ->      0
```

```
    1     ->     1
    2     ->     2
    3     ->     3

Enter a logical address (0 to 15): 6

Logical Address: 6
Page Number: 1, Offset: 2
Physical Address: 6 (Frame Number: 1, Offset: 2)
```

**Experiment No: 11**

**Aim: Implement Bankers Algorithm for Dead Lock avoidance and prevention**

**Source Code:**

```
#include <stdio.h>
#include <stdbool.h>
#define P 5
#define R 3
bool isSafe(int processes[], int avail[], int max[][R], int alloc[][R], int need[][R]) {
    int work[R], finish[P] = {0};
    for (int i = 0; i < R; i++) {
        work[i] = avail[i];
    }
        int safeSeq[P];
    int count = 0;
    while (count < P) {
        bool found = false;
        for (int p = 0; p < P; p++) {
            if (!finish[p]) {  // If process is not finished
                bool possible = true;
                for (int j = 0; j < R; j++) {
```

```
                if (need[p][j] > work[j]) {
                    possible = false;
                    break;
                }
            }
            if (possible) {
                for (int k = 0; k < R; k++) {
                    work[k] += alloc[p][k];
                }
                safeSeq[count++] = p;
                finish[p] = 1;
                found = true;
            }
        }
    }

    if (!found) {
        return false;
    }
}
printf("System is in a safe state.\nSafe sequence is: ");
for (int i = 0; i < P; i++) {
    printf("%d ", safeSeq[i]);
}
printf("\n");
return true;
}

int main() {
    int processes[P] = {0, 1, 2, 3, 4};
    int avail[R] = {3, 3, 2};
    int max[P][R] = {{7, 5, 3},
                    {3, 2, 2},
                    {9, 0, 2},
                    {2, 2, 2},
                    {4, 3, 3}};
    int alloc[P][R] = {{0, 1, 0},
                      {2, 0, 0},
                      {3, 0, 2},
                      {2, 1, 1},
                      {0, 0, 2}};

    int need[P][R];
    for (int i = 0; i < P; i++) {
        for (int j = 0; j < R; j++) {
            need[i][j] = max[i][j] - alloc[i][j];
        }
    }

    if (!isSafe(processes, avail, max, alloc, need)) {
        printf("System is not in a safe state.\n");
    }

    return 0;
}
```

**Output:**

```
System is in a safe state.
Safe sequence is: 1 3 4 0 2
```

**Experiment No: 12**

**Aim: Simulate the following file allocation strategies a) Sequential b) Linked c) Indexed**

a)Sequential Allocation Source Code:

```
#include <stdio.h>
#define MAX_BLOCKS 100
int blocks[MAX_BLOCKS];
void sequentialAllocation(int startBlock, int fileSize) {
    int i;
    for (i = startBlock; i< (startBlock + fileSize); i++) {
        if (blocks[i] == 1) {
printf("Block %d is already allocated. Sequential allocation failed.\n", i);
return;
        }
    }
    for (i = startBlock; i< (startBlock + fileSize); i++) {
        blocks[i] = 1;
    }
printf("File allocated using Sequential Allocation from block %d to block %d.\n", startBlock,
startBlock + fileSize - 1);
}

int main() {
    int startBlock, fileSize;
    for (int i = 0; i< MAX_BLOCKS; i++) {
        blocks[i] = 0;
    }
printf("Enter the starting block and file size: ");
scanf("%d%d", &startBlock, &fileSize);
sequentialAllocation(startBlock, fileSize);
```

```
    return 0;
}
```

**Output:**

```
Enter the starting block and file size: 5 3
File allocated using Sequential Allocation from block 5 to block 7.
```

b)**Linked allocation Source Code:**

```
#include <stdio.h>
#define MAX_BLOCKS 100
struct Block {
    int nextBlock;
    int isAllocated;
};
struct Block blocks[MAX_BLOCKS];
void linkedAllocation(int startBlock, int fileSize) {
    int count = 0, currentBlock = startBlock;

    while (count <fileSize) {
        if (blocks[currentBlock].isAllocated == 1) {
printf("Block %d is already allocated. Linked allocation failed.\n", currentBlock);
return;
        }
        blocks[currentBlock].isAllocated = 1;
        if (count <fileSize - 1) {
printf("Enter the next block number after %d: ", currentBlock);
scanf("%d", &blocks[currentBlock].nextBlock);
currentBlock = blocks[currentBlock].nextBlock;
        } else {
            blocks[currentBlock].nextBlock = -1; // End of file
        }
        count++;
    }
printf("File allocated using Linked Allocation starting from block %d.\n", startBlock);
}
int main() {
    int startBlock, fileSize;
    for (int i = 0; i< MAX_BLOCKS; i++) {
        blocks[i].isAllocated = 0;
        blocks[i].nextBlock = -1;
    }
printf("Enter the starting block and file size: ");
scanf("%d%d", &startBlock, &fileSize);
linkedAllocation(startBlock, fileSize);
    return 0;
}
```

**Output:**

```
Enter the starting block and file size: 3 3
Enter the next block number after 3: 5
Enter the next block number after 5: 7
File allocated using Linked Allocation starting from block 3.
```

**c)Indexed Allocation Source Code:**

```
#include <stdio.h>
#define MAX_BLOCKS 100
#define MAX_INDEX_SIZE 10
int blocks[MAX_BLOCKS];
int indexBlock[MAX_INDEX_SIZE];
void indexedAllocation(int indexBlockNo, int fileSize) {
    int i, dataBlock;
        for (i = 0; i< MAX_INDEX_SIZE; i++) {
indexBlock[i] = -1;
    }
printf("Enter the block numbers to store the file data:\n")
```

```
        for (i = 0; i<fileSize; i++) {
scanf("%d", &dataBlock);
        if (blocks[dataBlock] == 1) {
printf("Block %d is already allocated. Indexed allocation failed.\n", dataBlock);
return;
        }
        blocks[dataBlock] = 1;
indexBlock[i] = dataBlock;
    }
printf("File allocated using Indexed Allocation. Index block is at block %d.\n", indexBlockNo);
printf("Index block contents: ");
    for (i = 0; i<fileSize; i++) {
printf("%d ", indexBlock[i]);
    }
printf("\n");
}
int main() {
    int indexBlockNo, fileSize;
        for (int i = 0; i< MAX_BLOCKS; i++) {
        blocks[i] = 0;
    }
printf("Enter the index block number and file size: ");
scanf("%d%d", &indexBlockNo, &fileSize);
indexedAllocation(indexBlockNo, fileSize);
    return 0;
}
```

**Output:**

```
Enter the index block number and file size: 2 3
Enter the block numbers to store the file data:
5 7 9
File allocated using Indexed Allocation. Index block is at block 2.
Index block contents: 5 7 9
```

## Experiment No: 13

## Aim: Download and install nachos operating system and experiment with it

NACHOS (Not Another Completely Heuristic Operating System) is a pedagogical operating system designed for educational purposes. It allows students to implement and experiment with various operating system functionalities, including process management, memory management, file systems, and synchronization.

### 1. Install Prerequisites

Open the terminal and run the following command to install the required packages:

```
sudo apt update
```

```
sudo apt install build-essential gcc g++ git
```

### 2.Download NACHOS Source Code

download NACHOS from the Stanford NACHOS page

Change into the downloaded directory:

```
cd nachos
```

### 3.Compile NACHOS

Navigate to the code directory and compile the source code:

```
cd code
make clean
make
```

### 4.**Run NACHOS**

Run NACHOS to format the filesystem:

```
./nachos -f
```

Execute a sample program:

```
./nachos -x ../test/halt
```