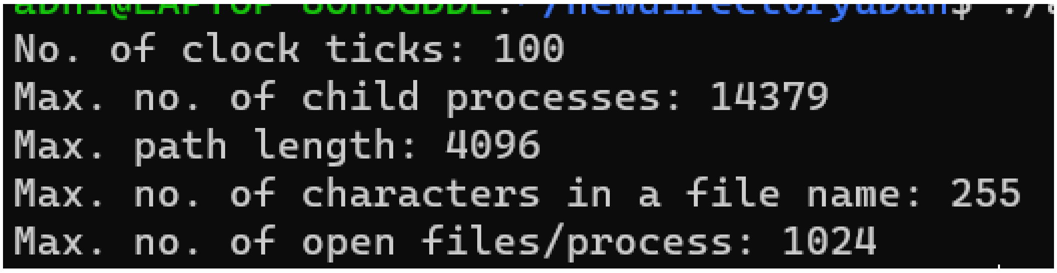
.31 . Check the following limits:
No. of clock ticks, Max. no. of child processes, Max. path length, Max. no. of characters in a file name, Max. no. of open files/ process

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

  int main() {
      // Check and print the number of clock ticks
      printf("No. of clock ticks: %ld\n", sysconf(_SC_CLK_TCK));

      // Check and print the max number of child processes
      printf("Max. no. of child processes: %ld\n", sysconf(_SC_CHILD_MAX));

      // Check and print the max path length
      printf("Max. path length: %ld\n", pathconf("/", _PC_PATH_MAX));

      // Check and print the max number of characters in a file name
      printf("Max. no. of characters in a file name: %ld\n", pathconf("/", _PC_NAME_MAX));

      // Check and print the max number of open files per process
      printf("Max. no. of open files/process: %ld\n", sysconf(_SC_OPEN_MAX));

      return 0;
  }
```

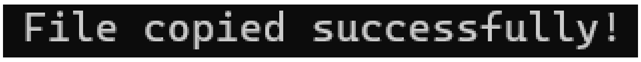
Output :



```
No. of clock ticks: 100
Max. no. of child processes: 14379
Max. path length: 4096
Max. no. of characters in a file name: 255
Max. no. of open files/process: 1024
```

2. a. Copy of a file using system calls.
   b. Output the contents of its Environment list

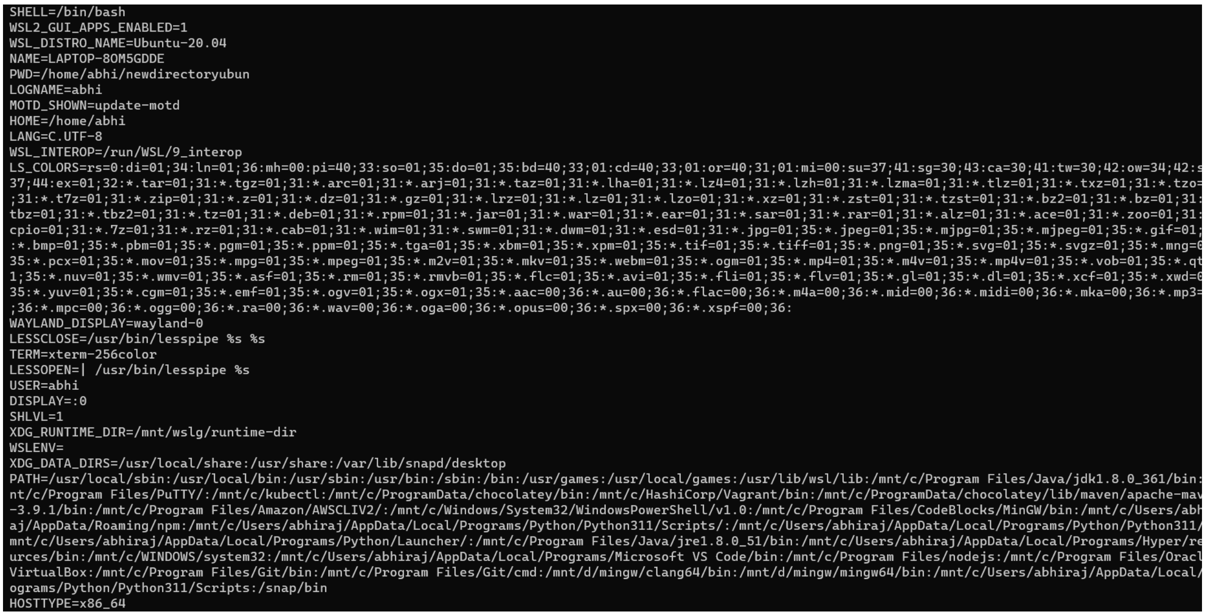
```
#include <iostream>
  #include <fstream>
  #include <cstdlib>
  #include <cstring>
  #include <sys/types.h>
  #include <sys/stat.h>
  #include <fcntl.h>
  #include <unistd.h>


int main() {
    const char* sourceFile = "source.txt";
    const char* destinationFile = "destination.txt";

    int source_fd = open(sourceFile, O_RDONLY);
    if (source_fd == -1) {
        perror("Error opening source file");
        return 1;
    }

    int dest_fd = open(destinationFile, O_WRONLY | O_CREAT, S_IRUSR | S_IWUSR);
    if (dest_fd == -1) {
        perror("Error opening destination file");
        close(source_fd);
        return 1;
    }

    char buffer[4096];
    ssize_t bytes_read;

    while ((bytes_read = read(source_fd, buffer, sizeof(buffer))) > 0) {
        ssize_t bytes_written = write(dest_fd, buffer, bytes_read);
        if (bytes_written != bytes_read) {
            perror("Error writing to destination file");
            close(source_fd);
            close(dest_fd);
            return 1;
        }
    }

    // Close file descriptors
    close(source_fd);
    close(dest_fd);

    std::cout << "File copied successfully!" << std::endl;

    return 0;
}
```



```
File copied successfully!
```

b. Output the contents of the Environment list:

```
#include <iostream>

extern char** environ;

int main() {
    char** env = environ;

    while (*env != nullptr) {
        std::cout << *env << std::endl;
        env++;
    }

    return 0;
}
```

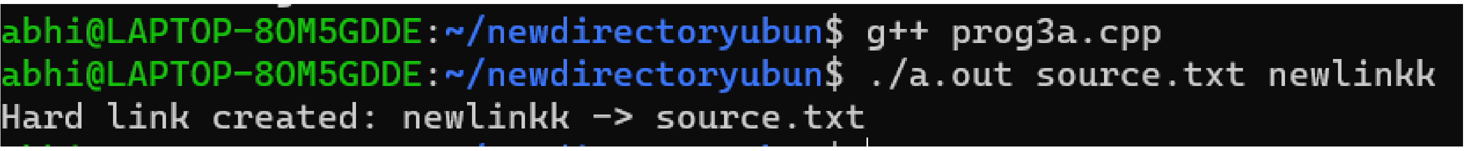


```
SHELL=/bin/bash
WSL2_GUI_APPS_ENABLED=1
WSL_DISTRO_NAME=Ubuntu-20.04
NAME=LAPTOP-8OM5GDDE
PWD=/home/abhi/newdirectoryubun
LOGNAME=abhi
MOTD_SHOWN=update-motd
HOME=/home/abhi
LANG=C.UTF-8
WSL_INTEROP=/run/WSL/9_interop
LS_COLORS=rs=0:di=01;34:ln=01;36:mh=00:pi=40;33:so=01;35:do=01;35:bd=40;33;01:cd=40;33;01:or=40;31;01:mi=00:su=37;41:sg=30;43:ca=30;41:tw=30;42:ow=34;42:s
37;44:ex=01;32:*.tar=01;31:*.tgz=01;31:*.arc=01;31:*.arj=01;31:*.taz=01;31:*.lha=01;31:*.lz4=01;31:*.lzh=01;31:*.lzma=01;31:*.tlz=01;31:*.txz=01;31:*.tzo=
;31:*.t7z=01;31:*.zip=01;31:*.z=01;31:*.dz=01;31:*.gz=01;31:*.lrz=01;31:*.lz=01;31:*.lzo=01;31:*.xz=01;31:*.zst=01;31:*.tzst=01;31:*.bz2=01;31:*.bz=01;31:
tbz=01;31:*.tbz2=01;31:*.tz=01;31:*.deb=01;31:*.rpm=01;31:*.jar=01;31:*.war=01;31:*.ear=01;31:*.sar=01;31:*.rar=01;31:*.alz=01;31:*.ace=01;31:*.zoo=01;31:
cpio=01;31:*.7z=01;31:*.rz=01;31:*.cab=01;31:*.wim=01;31:*.swm=01;31:*.dwm=01;31:*.esd=01;31:*.jpg=01;35:*.jpeg=01;35:*.mjpg=01;35:*.mjpeg=01;35:*.gif=01;
:*.bmp=01;35:*.pbm=01;35:*.pgm=01;35:*.ppm=01;35:*.tga=01;35:*.xbm=01;35:*.xpm=01;35:*.tif=01;35:*.tiff=01;35:*.png=01;35:*.svg=01;35:*.svgz=01;35:*.mng=0
35:*.pcx=01;35:*.mov=01;35:*.mpg=01;35:*.mpeg=01;35:*.m2v=01;35:*.mkv=01;35:*.webm=01;35:*.ogm=01;35:*.mp4=01;35:*.m4v=01;35:*.mp4v=01;35:*.vob=01;35:*.qt
1;35:*.nuv=01;35:*.wmv=01;35:*.asf=01;35:*.rm=01;35:*.rmvb=01;35:*.flc=01;35:*.avi=01;35:*.fli=01;35:*.flv=01;35:*.gl=01;35:*.dl=01;35:*.xcf=01;35:*.xwd=0
35:*.yuv=01;35:*.cgm=01;35:*.emf=01;35:*.ogv=01;35:*.ogx=01;35:*.aac=00;36:*.au=00;36:*.flac=00;36:*.m4a=00;36:*.mid=00;36:*.midi=00;36:*.mka=00;36:*.mp3=
;36:*.mpc=00;36:*.ogg=00;36:*.ra=00;36:*.wav=00;36:*.oga=00;36:*.opus=00;36:*.spx=00;36:*.xspf=00;36:
WAYLAND_DISPLAY=wayland-0
LESSCLOSE=/usr/bin/lesspipe %s %s
TERM=xterm-256color
LESSOPEN=| /usr/bin/lesspipe %s
USER=abhi
DISPLAY=:0
SHLVL=1
XDG_RUNTIME_DIR=/mnt/wslg/runtime-dir
WSLENV=
XDG_DATA_DIRS=/usr/local/share:/usr/share:/var/lib/snapd/desktop
PATH=/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin:/usr/games:/usr/local/games:/usr/lib/wsl/lib:/mnt/c/Program Files/Java/jdk1.8.0_361/bin:
nt/c/Program Files/PuTTY/:/mnt/c/kubectl:/mnt/c/ProgramData/chocolatey/bin:/mnt/c/HashiCorp/Vagrant/bin:/mnt/c/ProgramData/chocolatey/lib/maven/apache-mav
-3.9.1/bin:/mnt/c/Program Files/Amazon/AWSCLIV2/:/mnt/c/Windows/System32/WindowsPowerShell/v1.0:/mnt/c/Program Files/CodeBlocks/MinGW/bin:/mnt/c/Users/abh
aj/AppData/Roaming/npm:/mnt/c/Users/abhiraj/AppData/Local/Programs/Python/Python311/Scripts/:/mnt/c/Users/abhiraj/AppData/Local/Programs/Python/Python311/
mnt/c/Users/abhiraj/AppData/Local/Programs/Python/Launcher/:/mnt/c/Program Files/Java/jre1.8.0_51/bin:/mnt/c/Users/abhiraj/AppData/Local/Programs/Hyper/re
urces/bin:/mnt/c/WINDOWS/system32:/mnt/c/Users/abhiraj/AppData/Local/Programs/Microsoft VS Code/bin:/mnt/c/Program Files/nodejs:/mnt/c/Program Files/Oracl
VirtualBox:/mnt/c/Program Files/Git/bin:/mnt/c/Program Files/Git/cmd:/mnt/d/mingw/clang64/bin:/mnt/d/mingw/mingw64/bin:/mnt/c/Users/abhiraj/AppData/Local/
ograms/Python/Python311/Scripts:/snap/bin
HOSTTYPE=x86_64
```

3. a. Emulate the UNIX ln command
   b. Create a child from parent process using fork() and counter counts till 5 in both processes and displays.

a.

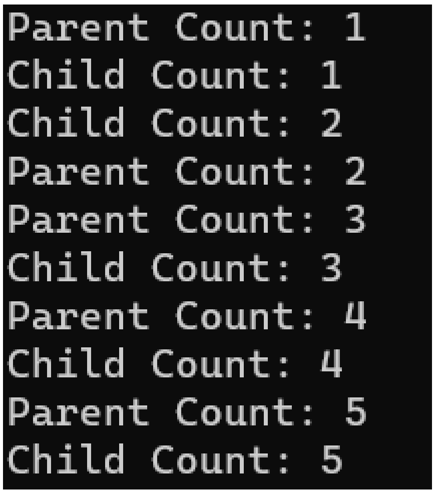
```
#include <iostream>
#include <unistd.h>

int main(int argc, char *argv[]) {
    if (argc != 3) {
        std::cerr << "Usage: " << argv[0] << " source_file target_file" << std::endl;
        return 1;
    }

    const char *source_file = argv[1];
    const char *target_file = argv[2];

    if (link(source_file, target_file) == 0) {
        std::cout << "Hard link created: " << target_file << " -> " << source_file << std::endl;
        return 0;
    } else {
        perror("Error creating hard link");
        return 2;
    }
}
```



```
abhi@LAPTOP-8OM5GDDE:~/newdirectoryubun$ g++ prog3a.cpp
abhi@LAPTOP-8OM5GDDE:~/newdirectoryubun$ ./a.out source.txt newlinkk
Hard link created: newlinkk -> source.txt
```

b.

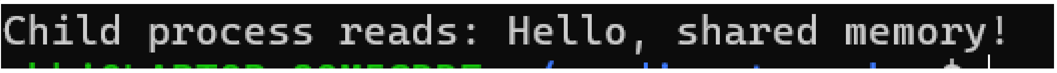
```
#include <iostream>
#include <unistd.h>

int main() {
    pid_t child_pid;
    // Fork a child process
    child_pid = fork();

    if (child_pid == -1) {
        std::cerr << "Fork failed." << std::endl;
        return 1;
    }

    for (int i = 1; i <= 5; i++) {
        if (child_pid == 0) {
            // Child process
            std::cout << "Child Count: " << i << std::endl;
        } else {
            // Parent process
            std::cout << "Parent Count: " << i << std::endl;
        }
        sleep(1); // Sleep for 1 second
    }

    return 0;
}
```



```
Parent Count: 1
Child Count: 1
Child Count: 2
Parent Count: 2
Parent Count: 3
Child Count: 3
Parent Count: 4
Child Count: 4
Parent Count: 5
Child Count: 5
```

4 . Illustrate two processes communicating using shared memory

```
#include <iostream>
#include <cstdlib>
#include <cstring>
#include <sys/types.h>
#include <sys/ipc.h>
#include <sys/shm.h>
#include <unistd.h>
#include <sys/wait.h>


// Define the shared memory key
#define SHM_KEY 1234
// Define the size of the shared memory segment
#define SHM_SIZE 1024

int main() {
    // Create a key for the shared memory segment
    key_t key = ftok(".", SHM_KEY);
    if (key == -1) {
        perror("ftok"); // Print an error message if ftok fails
        exit(1);
    }

    // Create (or get) a shared memory segment
    int shmid = shmget(key, SHM_SIZE, IPC_CREAT | 0666);
    if (shmid == -1) {
        perror("shmget"); // Print an error message if shmget fails
        exit(1);
    }

    // Attach the shared memory segment to the process's address space
    char *shm_ptr = (char *)shmat(shmid, NULL, 0);
    if (shm_ptr == (char *)(-1)) {
        perror("shmat"); // Print an error message if shmat fails
        exit(1);
    }

    // Parent process writes a message to shared memory
    std::string message = "Hello, shared memory!";
    std::strcpy(shm_ptr, message.c_str());

    // Fork a child process
    pid_t child_pid = fork();

    if (child_pid == -1) {
        perror("fork"); // Print an error message if fork fails
        exit(1);
    }

    if (child_pid == 0) {
        // Child process reads from shared memory and prints
        std::cout << "Child process reads: " << shm_ptr << std::endl;

        // Detach the shared memory segment from the child process
        if (shmdt(shm_ptr) == -1) {
            perror("shmdt"); // Print an error message if shmdt fails
            exit(1);
        }
    } else {
        // Parent process waits for the child to finish
        wait(NULL);

        // Detach the shared memory segment from the parent process
        if (shmdt(shm_ptr) == -1) {
            perror("shmdt"); // Print an error message if shmdt fails
            exit(1);
        }

        // Remove the shared memory segment
        if (shmctl(shmid, IPC_RMID, NULL) == -1) {
            perror("shmctl"); // Print an error message if shmctl fails
            exit(1);
        }
    }

    return 0;
}
```

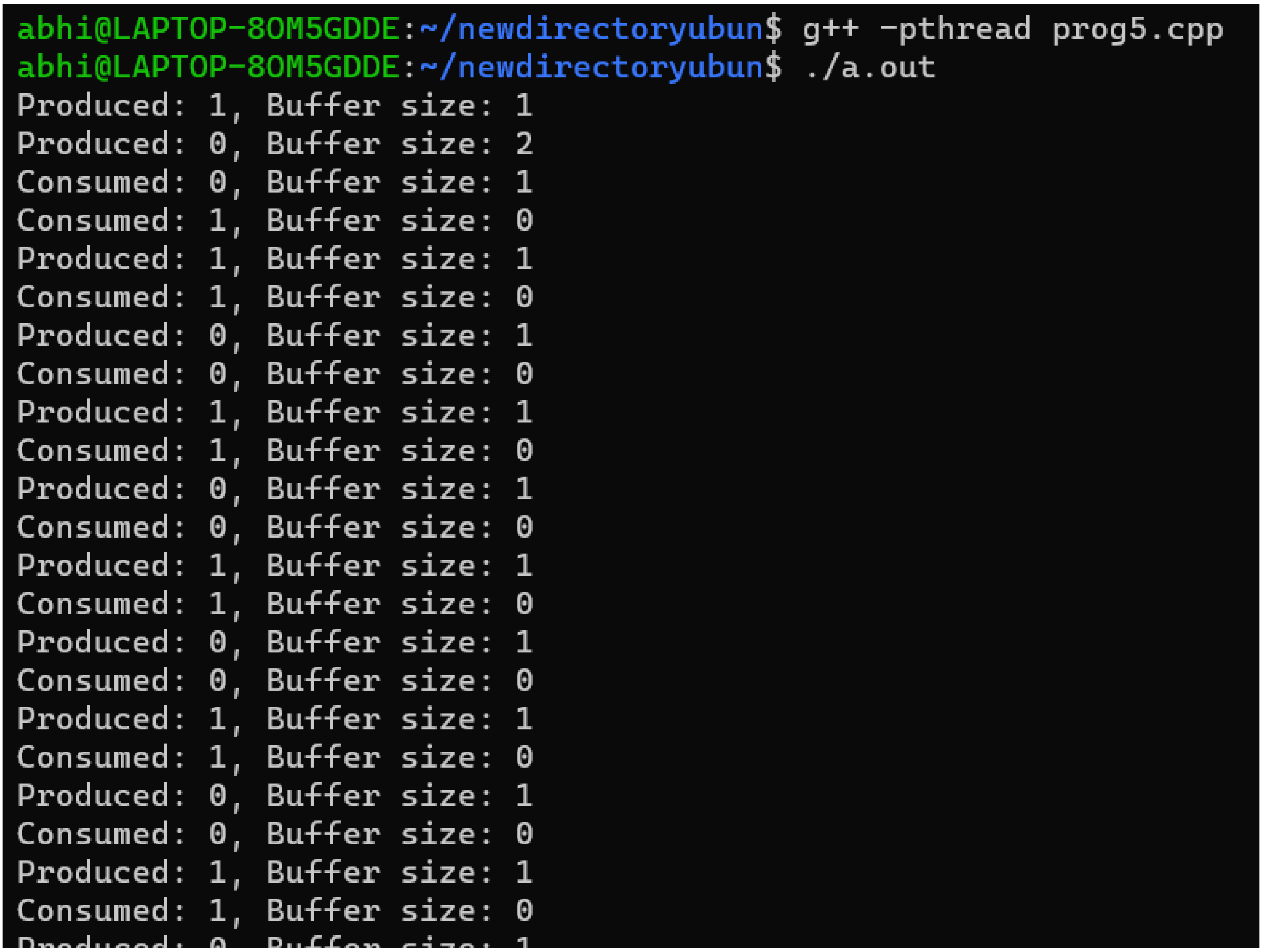


```
Child process reads: Hello, shared memory!
```

5. Demonstrate producer and consumer problem using semaphores

```
#include <iostream>
#include <pthread.h>
#include <semaphore.h>
#include <unistd.h>
#include <vector>

#define MAX_BUFFER_SIZE 5
#define NUM_PRODUCERS 2
#define NUM_CONSUMERS 2

std::vector<int> buffer; // Shared buffer
sem_t mutex;            // Semaphore for mutual exclusion
sem_t empty;            // Semaphore for tracking empty slots in the buffer
sem_t full;             // Semaphore for tracking filled slots in the buffer

void* producer(void* arg) {
   int item = *((int*)arg);
   while (true) {
      sleep(1);

      sem_wait(&empty); // Wait for an empty slot in the buffer
      sem_wait(&mutex); // Enter critical section

      buffer.push_back(item); // Produce an item and add it to the buffer
      std::cout << "Produced: " << item << ", Buffer size: " << buffer.size() << std::endl;

      sem_post(&mutex); // Exit critical section
      sem_post(&full);  // Signal that a slot in the buffer is filled
   }
   return NULL;
}

// Consumer function
void* consumer(void* arg) {
   while (true) {
      sleep(1); // Simulate time to consume an item

      sem_wait(&full);  // Wait for a filled slot in the buffer
      sem_wait(&mutex); // Enter critical section

      int item = buffer.back(); // Consume an item from the buffer
      buffer.pop_back();
      std::cout << "Consumed: " << item << ", Buffer size: " << buffer.size() << std::endl;

      sem_post(&mutex); // Exit critical section
      sem_post(&empty); // Signal that a slot in the buffer is empty
   }
   return NULL;}

int main() {
   // Initialize semaphores
   sem_init(&mutex, 0, 1);        // Mutex semaphore
   sem_init(&empty, 0, MAX_BUFFER_SIZE); // Empty semaphore (buffer slots available)
   sem_init(&full, 0, 0);        // Full semaphore (buffer slots filled)

   // Create producer and consumer threads
   pthread_t producer_threads[NUM_PRODUCERS];
```

```
    pthread_t consumer_threads[NUM_CONSUMERS];

    for (int i = 0; i < NUM_PRODUCERS; ++i) {
        int* item = new int(i);
        pthread_create(&producer_threads[i], NULL, producer, (void*)item);
    }

    for (int i = 0; i < NUM_CONSUMERS; ++i) {
        pthread_create(&consumer_threads[i], NULL, consumer, NULL);
    }

    // Join threads
    for (int i = 0; i < NUM_PRODUCERS; ++i) {
        pthread_join(producer_threads[i], NULL);
    }

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

    // Destroy semaphores
    sem_destroy(&mutex);
    sem_destroy(&empty);
    sem_destroy(&full);

    return 0;
}
```

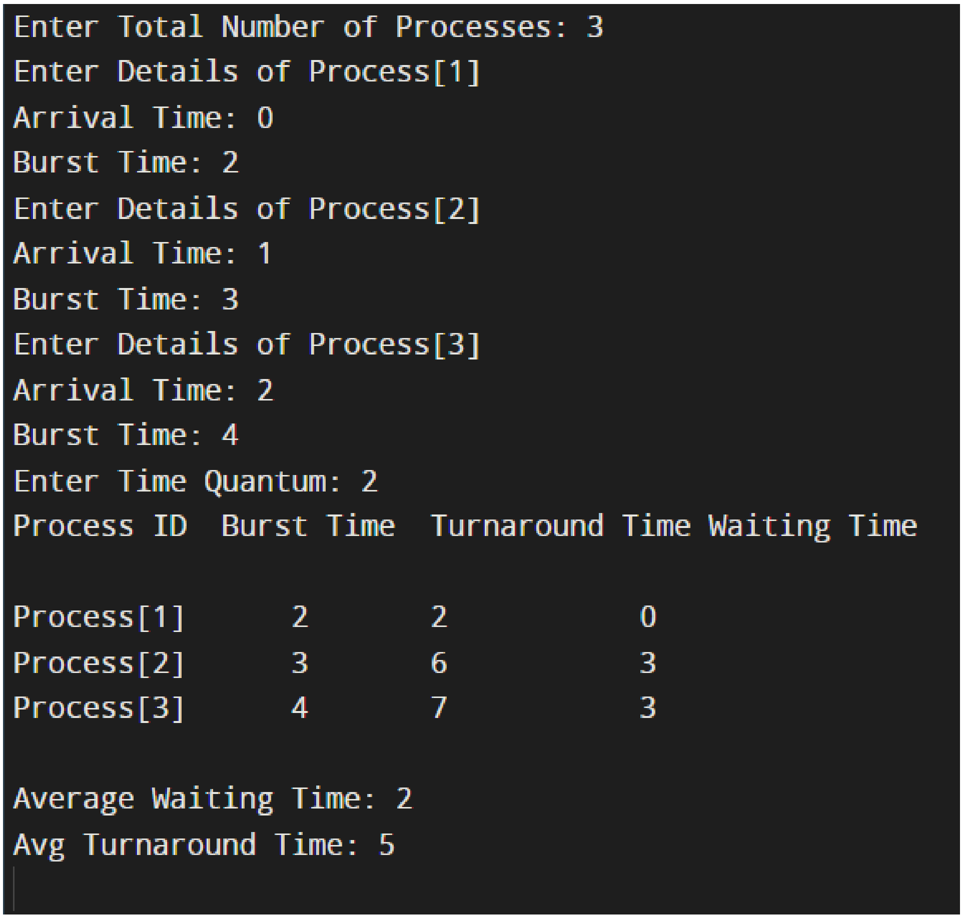


```
abhi@LAPTOP-8OM5GDDE:~/newdirectoryubun$ g++ -pthread prog5.cpp
abhi@LAPTOP-8OM5GDDE:~/newdirectoryubun$ ./a.out
Produced: 1, Buffer size: 1
Produced: 0, Buffer size: 2
Consumed: 0, Buffer size: 1
Consumed: 1, Buffer size: 0
Produced: 1, Buffer size: 1
Consumed: 1, Buffer size: 0
Produced: 0, Buffer size: 1
Consumed: 0, Buffer size: 0
Produced: 1, Buffer size: 1
Consumed: 1, Buffer size: 0
Produced: 0, Buffer size: 1
Consumed: 0, Buffer size: 0
Produced: 1, Buffer size: 1
Consumed: 1, Buffer size: 0
Produced: 0, Buffer size: 1
Consumed: 0, Buffer size: 0
Produced: 1, Buffer size: 1
Consumed: 1, Buffer size: 0
Produced: 0, Buffer size: 1
Consumed: 0, Buffer size: 0
Produced: 1, Buffer size: 1
Consumed: 1, Buffer size: 0
Produced: 0, Buffer size: 1
```

6 . Demonstrate round robin scheduling algorithm and calculates average waiting time and average turnaround time
//dont know weather the answer is right or wrong

```
// 6.ROUND ROBIN SCHEDULING

#include <iostream>
using namespace std;

int main() {
    int i, limit, total = 0, x, counter = 0, time_quantum;
    int wait_time = 0, turnaround_time = 0, arrival_time[10], burst_time[10], temp[10];
    float average_wait_time, average_turnaround_time;

    cout << "Enter Total Number of Processes: ";
    cin >> limit;
    x = limit;

    for (i = 0; i < limit; i++) {
        cout << "\nEnter Details of Process[" << i + 1 << "]\n";
        cout << "Arrival Time: ";
        cin >> arrival_time[i];
        cout << "Burst Time: ";
        cin >> burst_time[i];
        temp[i] = burst_time[i];
    }

    cout << "\nEnter Time Quantum: ";
    cin >> time_quantum;

    cout << "\nProcess ID\tBurst Time\tTurnaround Time\tWaiting Time\n";
    for (total = 0, i = 0; x != 0;) {
        if (temp[i] <= time_quantum && temp[i] > 0) {
            total += temp[i];
            temp[i] = 0;
            counter = 1;
        } else if (temp[i] > 0) {
            temp[i] -= time_quantum;
            total += time_quantum;
        }

        if (temp[i] == 0 && counter == 1) {
            x--;
            cout << "\nProcess[" << i + 1 << "]\t\t" << burst_time[i] << "\t\t" << total - arrival_time[i] << "\t\t\t" << total -
arrival_time[i] - burst_time[i];
            wait_time += total - arrival_time[i] - burst_time[i];
            turnaround_time += total - arrival_time[i];
            counter = 0;
        }

        if (i == limit - 1)
            i = 0;
        else if (arrival_time[i + 1] <= total)
            i++;
        else
            total++;
    }

    average_wait_time = wait_time * 1.0 / limit;
    average_turnaround_time = turnaround_time * 1.0 / limit;

    cout << "\n\nAverage Waiting Time: " << average_wait_time;
    cout << "\nAvg Turnaround Time: " << average_turnaround_time << endl;

    return 0;
}
```

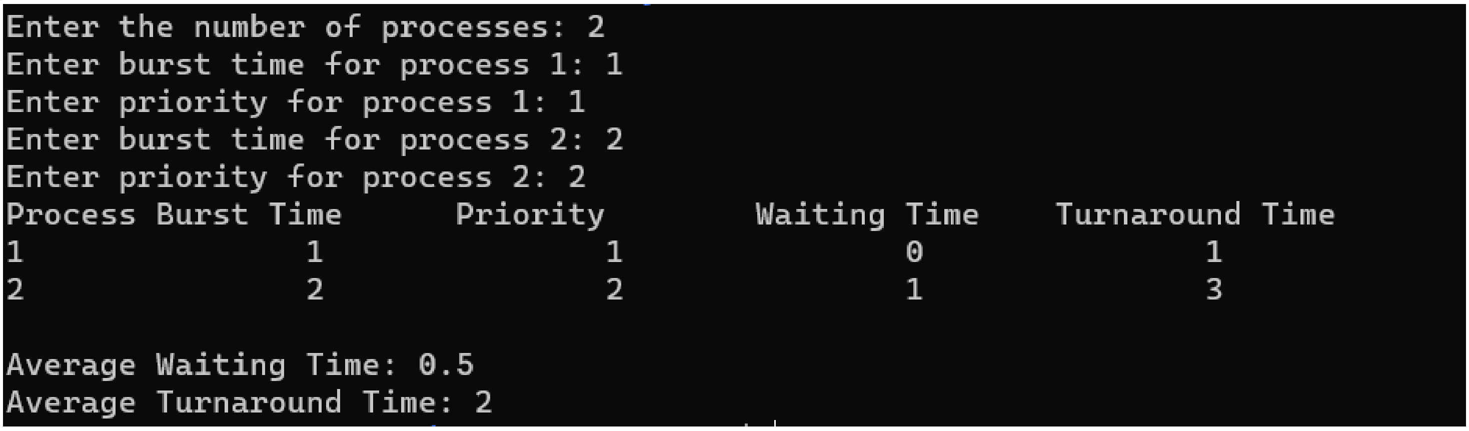
Output :



```
Enter Total Number of Processes: 3
Enter Details of Process[1]
Arrival Time: 0
Burst Time: 2
Enter Details of Process[2]
Arrival Time: 1
Burst Time: 3
Enter Details of Process[3]
Arrival Time: 2
Burst Time: 4
Enter Time Quantum: 2
Process ID  Burst Time  Turnaround Time Waiting Time

Process[1]      2       2           0
Process[2]      3       6           3
Process[3]      4       7           3

Average Waiting Time: 2
Avg Turnaround Time: 5
```

7. Implement priority-based scheduling algorithm and calculates average waiting time and average turnaround time

```
#include <iostream>
#include <vector>
#include <algorithm>

using namespace std;

struct Process {
    int processID;
    int burstTime;
    int priority;
    int waitingTime;
    int turnaroundTime;
};

bool comparePriority(const Process &a, const Process &b) {
    return a.priority < b.priority;
}

int main() {
    int numProcesses;
    cout << "Enter the number of processes: ";
    cin >> numProcesses;

    vector<Process> processes(numProcesses);

    for (int i = 0; i < numProcesses; i++) {
        processes[i].processID = i + 1;
        cout << "Enter burst time for process " << i + 1 << ": ";
        cin >> processes[i].burstTime;
        cout << "Enter priority for process " << i + 1 << ": ";
        cin >> processes[i].priority;
    }

    sort(processes.begin(), processes.end(), comparePriority);

    processes[0].waitingTime = 0;
    processes[0].turnaroundTime = processes[0].burstTime;

    for (int i = 1; i < numProcesses; i++) {
        processes[i].waitingTime = processes[i - 1].waitingTime + processes[i - 1].burstTime;
        processes[i].turnaroundTime = processes[i].waitingTime + processes[i].burstTime;
    }

    double totalWaitingTime = 0;
    double totalTurnaroundTime = 0;

    for (const Process &p : processes) {
        totalWaitingTime += p.waitingTime;
        totalTurnaroundTime += p.turnaroundTime;
    }

    double averageWaitingTime = totalWaitingTime / numProcesses;
    double averageTurnaroundTime = totalTurnaroundTime / numProcesses;

    cout << "Process\tBurst Time\tPriority\tWaiting Time\tTurnaround Time\n";
    for (const Process &p : processes) {
        cout << p.processID << "\t\t" << p.burstTime << "\t\t" << p.priority << "\t\t" << p.waitingTime << "\t\t" <<
p.turnaroundTime << endl;
    }

    cout << "\nAverage Waiting Time: " << averageWaitingTime << endl;
    cout << "Average Turnaround Time: " << averageTurnaroundTime << endl;

    return 0;
}
```



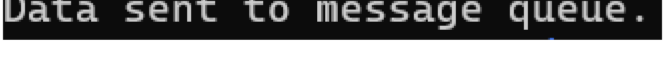
```
Enter the number of processes: 2
Enter burst time for process 1: 1
Enter priority for process 1: 1
Enter burst time for process 2: 2
Enter priority for process 2: 2
Process Burst Time      Priority        Waiting Time    Turnaround Time
1               1               1               0               1
2               2               2               1               3

Average Waiting Time: 0.5
Average Turnaround Time: 2
```

8. Act as sender to send data in message queues and receiver that reads data from message queue.

```
Sender.cpp
#include <iostream>
#include <cstring>
#include <cstdlib>
#include <unistd.h>
```

```
#include <sys/types.h>
#include <sys/ipc.h>
#include <sys/msg.h>

using namespace std;

// Define a structure for the message data
struct Message {
    long mtype;
    char mtext[100];
};

int main() {
    key_t key;
    int msgid;
    Message message;

    // Step 1: Create a key for the message queue
    key = ftok("/tmp", '1');
    if (key == -1) {
        perror("ftok");
        exit(1);
    }

    // Step 2: Create or open the message queue
    msgid = msgget(key, 0666 | IPC_CREAT);
    if (msgid == -1) {
        perror("msgget");
        exit(1);
    }

    // Sender: Send data to the message queue
    message.mtype = 1; // Message type (you can use different types for different purposes)
    strcpy(message.mtext, "Hello, this is a message from the sender!");

    // Step 3: Send the message to the queue
    if (msgsnd(msgid, &message, sizeof(message.mtext), 0) == -1) {
        perror("msgsnd");
        exit(1);
    }

    cout << "Data sent to message queue." << endl;

    return 0;
}
```

Output :



```
Data sent to message queue.
```

Receiver.cpp

```
#include <iostream>
#include <cstring>
#include <cstdlib>
#include <unistd.h>
#include <sys/types.h>
#include <sys/ipc.h>
#include <sys/msg.h>

using namespace std;

// Define a structure for the message data
```

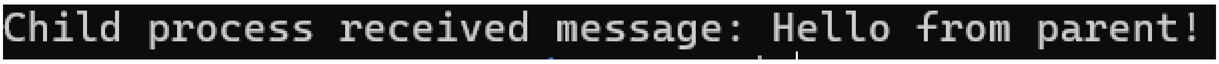
```
struct Message {
    long mtype;
    char mtext[100];
};

int main() {
    key_t key;
    int msgid;
    Message message;

    // Step 1: Create a key for the message queue (use the same key as in the sender)
    key = ftok("/tmp", '1');
    if (key == -1) {
        perror("ftok");
        exit(1);
    }

    // Step 2: Create or open the message queue
    msgid = msgget(key, 0666 | IPC_CREAT);
    if (msgid == -1) {
        perror("msgget");
        exit(1);
    }

    // Receiver: Read data from the message queue
    // Step 3: Receive a message from the queue with message type 1
    if (msgrcv(msgid, &message, sizeof(message.mtext), 1, 0) == -1) {
        perror("msgrcv");
        exit(1);
    }

    cout << "Data received gmessage queue: " << message.mtext << endl;

    return 0;
}
```

Output :

```
Data received from message queue: Hello, this is a message from the sender!
```

9. Where a parent writes a message to pipe and child reads message from pipe

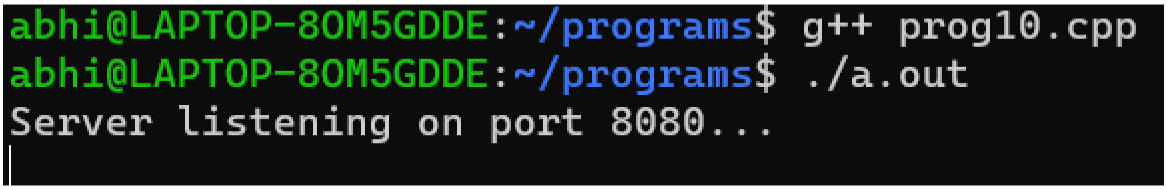
```
#include <iostream>
#include <unistd.h>

int main() {
    int pipe_fd[2]; // File descriptors for the pipe

    // Create a pipe
    if (pipe(pipe_fd) == -1) {
        perror("Pipe creation failed");
        return 1;
    }

    pid_t child_pid = fork(); // Fork a child process

    if (child_pid == -1) {
        perror("Fork failed");
        return 1;
    }
    if (child_pid > 0) { // Parent process
        close(pipe_fd[0]); // Close the read end in the parent

        std::string message = "Hello from parent!";

        // Write the message to the pipe
        if (write(pipe_fd[1], message.c_str(), message.length()) == -1) {
            perror("Write to pipe failed");
            return 1;
        }

        close(pipe_fd[1]); // Close the write end in the parent
    } else { // Child process
        close(pipe_fd[1]); // Close the write end in the child

        char buffer[50];
        ssize_t bytes_read;

        // Read the message from the pipe
        bytes_read = read(pipe_fd[0], buffer, sizeof(buffer));

        if (bytes_read == -1) {
            perror("Read from pipe failed");
            return 1;
        }

        buffer[bytes_read] = '\0'; // Null-terminate the string

        std::cout << "Child process received message: " << buffer << std::endl;

        close(pipe_fd[0]); // Close the read end in the child
    }

    return 0;
}
```



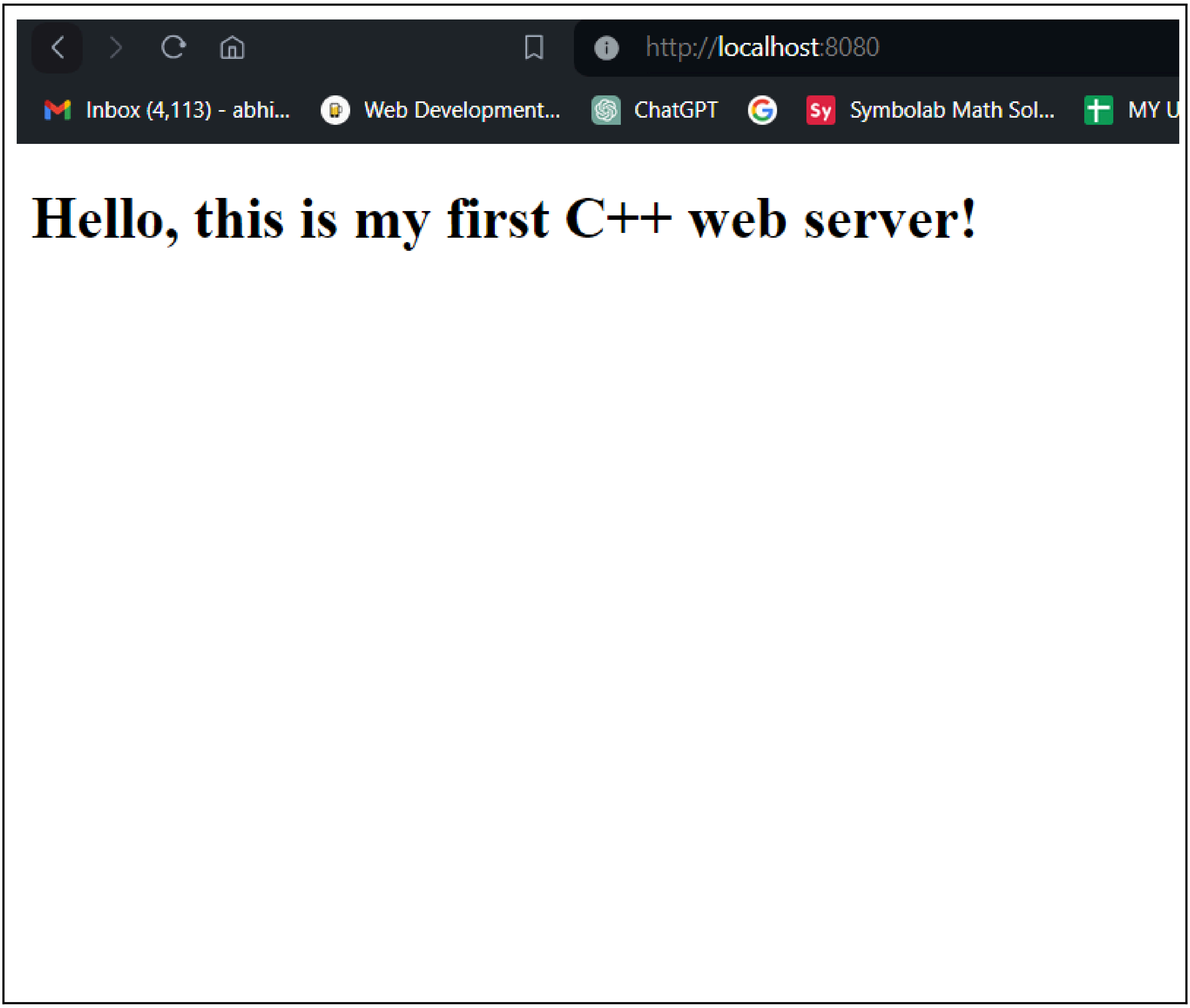
```
Child process received message: Hello from parent!
```

10. Demonstrate setting up a simple web server and host website on your own Linux computer

```
#include <iostream>
#include <cstring>
#include <unistd.h>
#include <sys/socket.h>
#include <netinet/in.h>

const int PORT = 8080;

void handle_request(int client_socket) {
    const char* response = "HTTP/1.1 200 OK\r\nContent-Type: text/html\r\n\r\n<!DOCTYPE
html><html><head><title>My C++ Web Server</title></head><body><h1>Hello, this is my first C++ web
server!</h1></body></html>";
    send(client_socket, response, strlen(response), 0);
    close(client_socket);
}

int main() {
    int server_socket = socket(AF_INET, SOCK_STREAM, 0);
    if (server_socket == -1) {
        std::cerr << "Error creating server socket" << std::endl;
        return -1;
    }

    sockaddr_in server_address{};
    server_address.sin_family = AF_INET;
    server_address.sin_addr.s_addr = INADDR_ANY;
    server_address.sin_port = htons(PORT);

    if (bind(server_socket, (struct sockaddr*)&server_address, sizeof(server_address)) == -1) {
        std::cerr << "Error binding to port " << PORT << std::endl;
        close(server_socket);
        return -1;
    }

    if (listen(server_socket, 10) == -1) {
        std::cerr << "Error listening on port " << PORT << std::endl;
        close(server_socket);
        return -1;
    }

    std::cout << "Server is listening on port " << PORT << std::endl;

    while (true) {
        sockaddr_in client_address{};
        socklen_t client_address_len = sizeof(client_address);

        int client_socket = accept(server_socket, (struct sockaddr*)&client_address, &client_address_len);
        if (client_socket == -1) {
            std::cerr << "Error accepting connection" << std::endl;
            continue;
        }

        handle_request(client_socket);
    }

    close(server_socket);

    return 0;
}
```



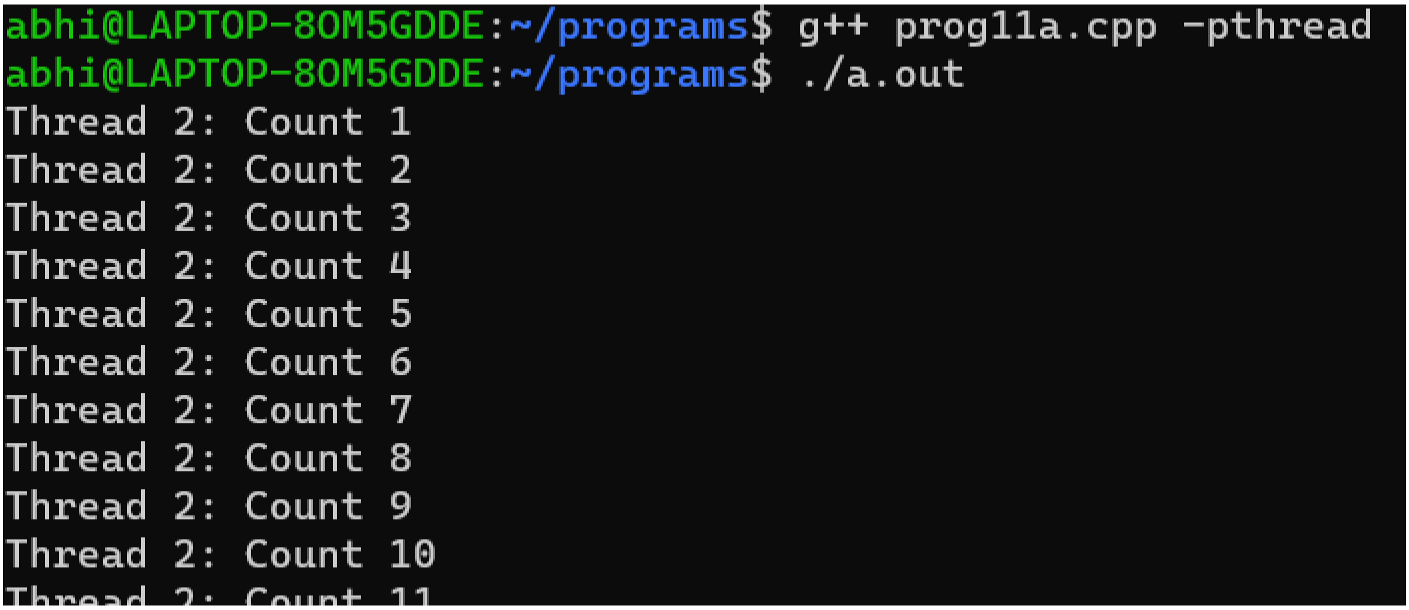
```
abhi@LAPTOP-8OM5GDDE:~/programs$ g++ prog10.cpp
abhi@LAPTOP-8OM5GDDE:~/programs$ ./a.out
Server listening on port 8080...
```



Hello, this is my first C++ web server!

11. a. Create two threads using pthread, where both thread counts until 100 and joins later.
b. Create two threads using pthreads. Here, main thread creates 5 other threads for 5 times and each new thread print “Hello World” message with its thread number

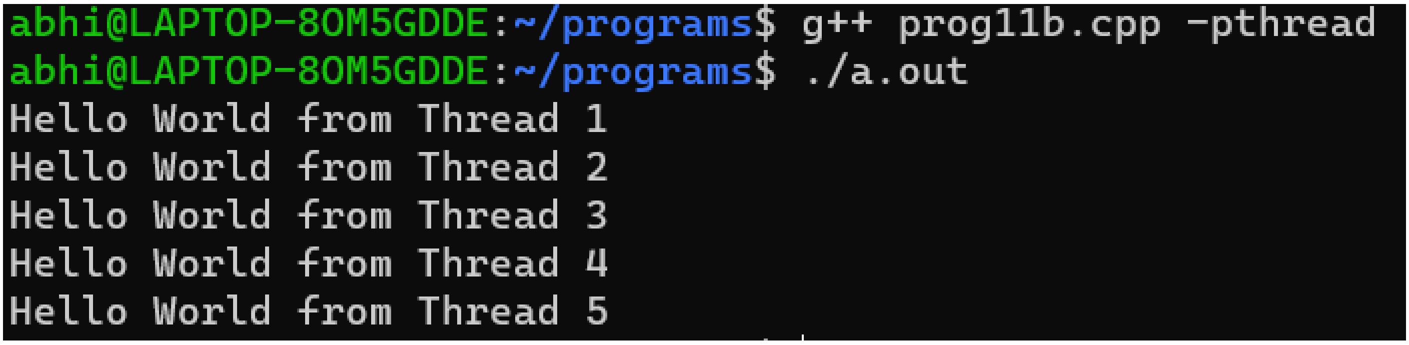
```
a.
#include <iostream>
#include <pthread.h>

// Function that will be executed by each thread
void* countTo100(void* arg) {
     int item = *((int*)arg);

   for (int i = 1; i <= 100; ++i) {
       std::cout << "Thread " << item << ": Count " << i << std::endl;
   }

   pthread_exit(NULL);
}

int main() {
    const int numThreads = 2;
    pthread_t threads[numThreads];

    // Loop to create threads
    for (int i = 0; i < numThreads; ++i) {
  int* item = new int(i);
        int threadCreateStatus = pthread_create(&threads[i], NULL, countTo100, (void*)item);

        if (threadCreateStatus) {
            std::cerr << "Error creating thread: " << threadCreateStatus << std::endl;
            return -1;
        }
    }

    // Wait for both threads to finish
    for (int i = 0; i < numThreads; ++i) {
        pthread_join(threads[i], NULL);
    }

    return 0;
}
```



```
abhi@LAPTOP-8OM5GDDE:~/programs$ g++ prog11a.cpp -pthread
abhi@LAPTOP-8OM5GDDE:~/programs$ ./a.out
Thread 2: Count 1
Thread 2: Count 2
Thread 2: Count 3
Thread 2: Count 4
Thread 2: Count 5
Thread 2: Count 6
Thread 2: Count 7
Thread 2: Count 8
Thread 2: Count 9
Thread 2: Count 10
Thread 2: Count 11
```

b.

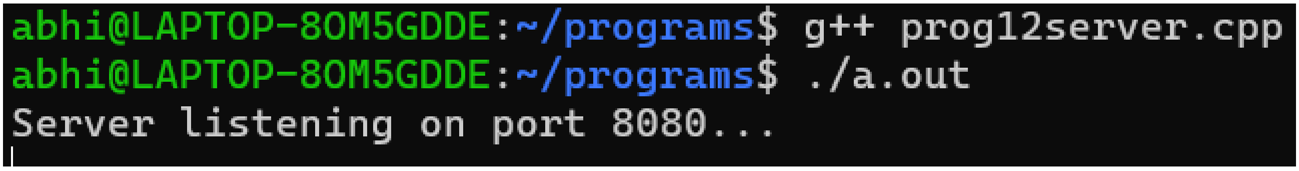
```
#include <iostream>
#include <pthread.h>

// Function that will be executed by each thread
void* printHello(void* threadNumber) {
    int* num = static_cast<int*>(threadNumber);
    std::cout << "Hello World from Thread " << *num << std::endl;
    pthread_exit(NULL);
}

int main() {
    // Number of threads to create
    const int numThreads = 5;

    // Loop to create threads
    for (int i = 1; i <= numThreads; ++i) {
        pthread_t thread;
        // Create a thread and pass the thread number as an argument
        int threadNumber = i;
        int threadCreateStatus = pthread_create(&thread, NULL, printHello, &threadNumber);

        if (threadCreateStatus) {
            std::cerr << "Error creating thread: " << threadCreateStatus << std::endl;
            return -1;
        }

        // Wait for the thread to finish
        pthread_join(thread, NULL);
    }

    return 0;
}
```



```
abhi@LAPTOP-8OM5GDDE:~/programs$ g++ prog11b.cpp -pthread
abhi@LAPTOP-8OM5GDDE:~/programs$ ./a.out
Hello World from Thread 1
Hello World from Thread 2
Hello World from Thread 3
Hello World from Thread 4
Hello World from Thread 5
```

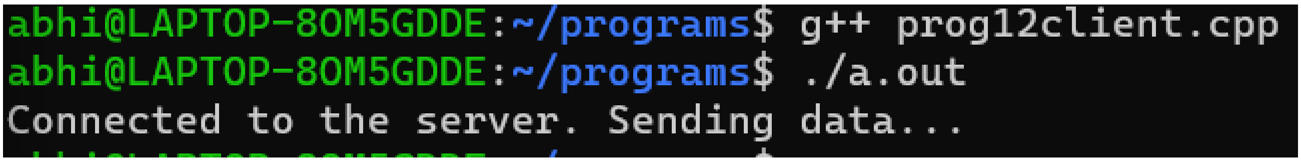
12. Using Socket APIs establish communication between remote and local processes

```
//server.cpp
#include <iostream>
#include <cstring>
#include <unistd.h>
#include <arpa/inet.h>

int main() {
    // Step 1: Create a socket
    int serverSocket = socket(AF_INET, SOCK_STREAM, 0);

    // Check for errors
    if (serverSocket == -1) {
        std::cerr << "Error creating socket." << std::endl;
        return -1;
    }

    // Step 2: Bind the socket to an IP address and port
    sockaddr_in serverAddress;
    serverAddress.sin_family = AF_INET;
    serverAddress.sin_addr.s_addr = INADDR_ANY;
    serverAddress.sin_port = htons(8080); // Port 8080

    // Bind the socket
    if (bind(serverSocket, (struct sockaddr*)&serverAddress, sizeof(serverAddress)) == -1) {
        std::cerr << "Error binding socket." << std::endl;
        close(serverSocket);
        return -1;
    }

    // Step 3: Listen for incoming connections
    if (listen(serverSocket, 5) == -1) {
        std::cerr << "Error listening for connections." << std::endl;
        close(serverSocket);
        return -1;
    }

    std::cout << "Server listening on port 8080..." << std::endl;

    // Step 4: Accept a connection
    sockaddr_in clientAddress;
    socklen_t clientAddrSize = sizeof(clientAddress);
    int clientSocket = accept(serverSocket, (struct sockaddr*)&clientAddress, &clientAddrSize);

    // Check for errors
    if (clientSocket == -1) {
        std::cerr << "Error accepting connection." << std::endl;
        close(serverSocket);
        return -1;
    }

    std::cout << "Connection accepted. Waiting for data..." << std::endl;

    // Step 5: Receive data from the client
    char buffer[1024];
    ssize_t bytesRead = recv(clientSocket, buffer, sizeof(buffer), 0);

    // Check for errors
    if (bytesRead == -1) {
        std::cerr << "Error receiving data." << std::endl;
        close(serverSocket);
        close(clientSocket);
        return -1;
    }

    // Step 6: Print the received data
    std::cout << "Received data from client: " << buffer << std::endl;

    // Step 7: Close the sockets
    close(serverSocket);
    close(clientSocket);

    return 0;
}
```



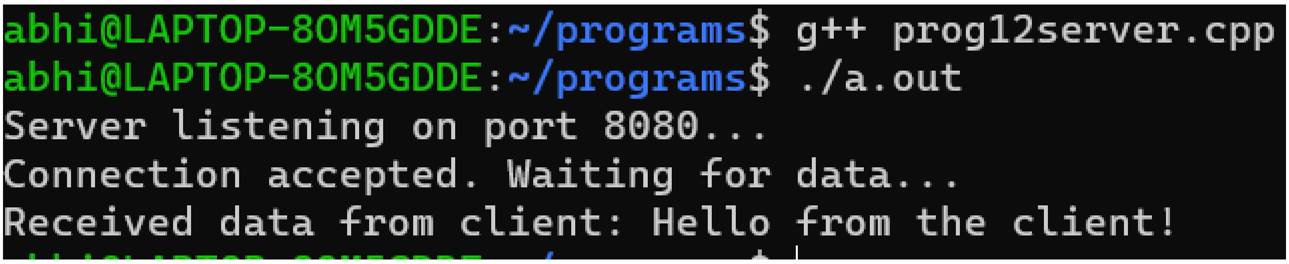
```
abhi@LAPTOP-8OM5GDDE:~/programs$ g++ prog12server.cpp
abhi@LAPTOP-8OM5GDDE:~/programs$ ./a.out
Server listening on port 8080...
```

```
//client.cpp
#include <iostream>
#include <cstring>
#include <unistd.h>
#include <arpa/inet.h>

int main() {
    // Step 1: Create a socket
    int clientSocket = socket(AF_INET, SOCK_STREAM, 0);

    // Check for errors
    if (clientSocket == -1) {
        std::cerr << "Error creating socket." << std::endl;
        return -1;
    }
    // Step 2: Set up the server address and port
    sockaddr_in serverAddress;
    serverAddress.sin_family = AF_INET;
    serverAddress.sin_port = htons(8080); // Port 8080

    // Convert IP address from text to binary form
    if (inet_pton(AF_INET, "127.0.0.1", &serverAddress.sin_addr) <= 0) {
        std::cerr << "Invalid address/Address not supported." << std::endl;
        close(clientSocket);
        return -1;
    }

    // Step 3: Connect to the server
    if (connect(clientSocket, (struct sockaddr*)&serverAddress, sizeof(serverAddress)) == -1) {
        std::cerr << "Connection failed." << std::endl;
        close(clientSocket);
        return -1;
    }

    std::cout << "Connected to the server. Sending data..." << std::endl;

    // Step 4: Send data to the server
    const char* message = "Hello from the client!";
    if (send(clientSocket, message, strlen(message), 0) == -1) {
        std::cerr << "Error sending data." << std::endl;
        close(clientSocket);
        return -1;
    }

    // Step 5: Close the socket
    close(clientSocket);

    return 0;
}
```



```
abhi@LAPTOP-8OM5GDDE:~/programs$ g++ prog12client.cpp
abhi@LAPTOP-8OM5GDDE:~/programs$ ./a.out
Connected to the server. Sending data...
```

//server console



```
abhi@LAPTOP-8OM5GDDE:~/programs$ g++ prog12server.cpp
abhi@LAPTOP-8OM5GDDE:~/programs$ ./a.out
Server listening on port 8080...
Connection accepted. Waiting for data...
Received data from client: Hello from the client!
```