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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

OPERATING SYSTEMS

BEEC3453	SEMESTER 1	SESI 2021/2022

LAB 5: SOCKET PROGRAMMING

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EXAMINER'S COMMENT(S)	TOTAL MARKS

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1. LEARNING OUTCOMES

1. Differentiate the functionality among various kinds of OS components.
2. Manipulate OS theories to solve basic functional problems.
3. Perform lab and present technical report in writing.

2. REQUIREMENTS

1. PC with Linux Ubuntu installed (or any other POSIX-compliant system)
2. Knowledge of C programming language

3. SYNOPSIS & THEORY

Most inter-process communication uses the **client server model**. These terms refer to the two processes which will be communicating with each other. One of the two processes, the **client**, connects to the other process, the **server**, typically to make a **request for information**. A good analogy is a person who makes a phone call to another person.

Note that the **client** needs to know of the **existence** of and the **address** of the **server**, but the server does not need to know the address of (or even the existence of) the client prior to the connection being established. Also note that once a **connection is established**, both sides can **send and receive information**.

The system calls for establishing a connection are somewhat different for the client and the server, but both involve the **basic construct of a socket**. A socket is one end of an inter-process communication channel. The two processes each establish their own socket.

The **steps** involved in establishing a **socket on the client side** are as follows:

- **Create** a socket with the **`socket()`** system call
- **Connect** the socket to the address of the **server** using the **`connect()`** system call
- **Send** and **receive data**. There are a number of ways to do this, but the simplest is to use the **`send()`** and **`recv()`** system calls

The **steps** involved in establishing a **socket on the server side** are as follows:

- **Create** a socket with the **`socket()`** system call
- **Bind** the socket to an address using the **`bind()`** system call. For a server socket on the internet, an address consists of a port number on the host machine
- **Listen for connections** with the **`listen()`** system call
- **Accept a connection** with the **`accept()`** system call. This call typically blocks until a client connects with the server
- **Send** and **receive data** with **`send()`** and **`recv()`** system calls

4. PROCEDURES

PART 1: The Server

1. In terminal open a **text editor**.
2. Save the file as "server.c".
3. Write the code below into "**server.c**":

```
#include <sys/types.h>
#include <sys/socket.h>
#include <netinet/in.h>
#include <arpa/inet.h>
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <errno.h>
#include <string.h>

#define   RED   "\x1B[31m"
#define  GREEN  "\x1B[32m"
#define  YELLOW  "\x1B[33m"
#define   BLUE   "\x1B[34m"
#define MAGENTA "\x1B[35m"
#define   CYAN   "\x1B[36m"
#define  WHITE  "\x1B[37m"
#define RESET  "\033[0m"





int main()
{
    system("clear");

    /*
    printf(RED "red\t" RESET);
    printf(GREEN "green\t" RESET);
    printf(YELLOW "yellow\t" RESET);
    printf(BLUE "blue\t" RESET);
    printf(MAGENTA "magenta\t" RESET);
    printf(CYAN "cyan\t" RESET);
    printf(WHITE "white\t\n" RESET);
    printf("This is " RED "red" RESET " and this is "
BLUE "blue" RESET "\n");
    */

    int sock;
    int connected;
    int receivedBytes;
    int true = 1;
    char outgoing [1024];
    char incoming[1024];
```

```
    struct sockaddr_in server_addr;
    struct sockaddr_in client_addr;
    int sin_size;

    if ((sock = socket(AF_INET, SOCK_STREAM, 0)) == -1)
    {
        perror("Socket Error");
        exit(1);
    }

    if (setsockopt(sock, SOL_SOCKET, SO_REUSEADDR,
&true, sizeof(int)) == -1)
    {
        perror("Setsockopt Error");
        exit(1);
    }

    server_addr.sin_family = AF_INET;
    server_addr.sin_port = htons(5000);
    server_addr.sin_addr.s_addr = INADDR_ANY;
    bzero(&(server_addr.sin_zero),8);

    if (bind(sock, (struct sockaddr *)&server_addr,
sizeof(struct sockaddr)) == -1)
    {
        perror("Bind Error");
        exit(1);
    }

    if (listen(sock, 5) == -1)
    {
        perror("Listen Error");
        exit(1);
    }

    printf(YELLOW "TCP server is now up and
running...\n" RESET);
    printf(YELLOW "Now please run the client
program!\n" RESET);
    fflush(stdout);

    sin_size = sizeof(struct sockaddr_in);
    connected = accept(sock, (struct  sockaddr
*)&client_addr, &sin_size);

     printf(YELLOW "Connection received from %s on  port
%d\n" RESET, inet_ntoa(client_addr.sin_addr),
ntohs(client_addr.sin_port));
    printf(YELLOW "Chat server & client connection
successful.\n\n" RESET);

    printf("************************ CHAT PROGRAM
(SERVER) ************************\n");
```

```
    while(1)
    {
        printf(BLUE "SERVER: " RESET);
        fgets(outgoing, sizeof(outgoing), stdin);
        send(connected, outgoing, strlen(outgoing),  0);

        receivedBytes = recv(connected, incoming,  1024,
0);
        incoming[receivedBytes] =  '\0';
        printf(GREEN "CLIENT: %s" RESET, incoming);
        fflush(stdout);
    }
    close(sock);
    return 0;
}
```

4. **Compile** the code and make sure there's **no error**.

5. Obviously, it wouldn't make any sense to run the server program without a client program, so move on to Part 2.

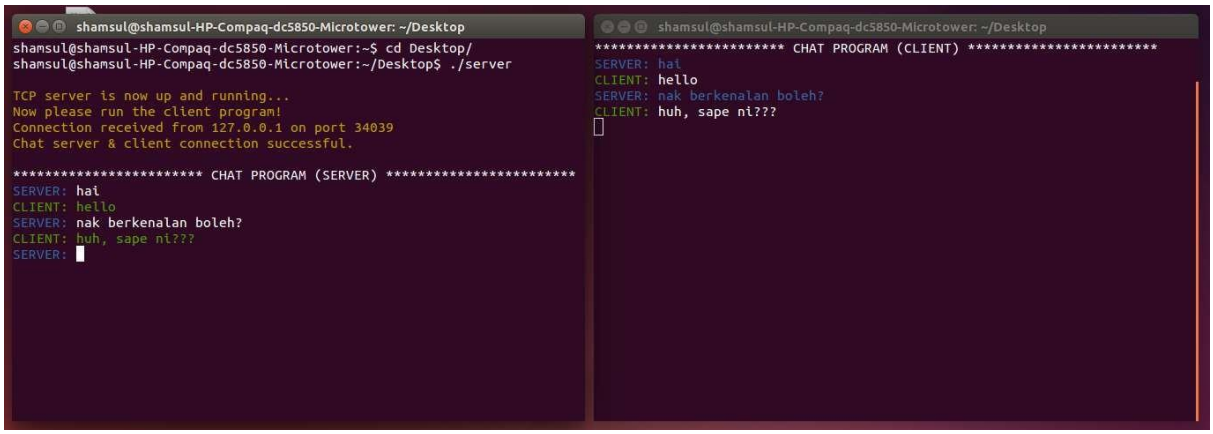
PART 2: The Client

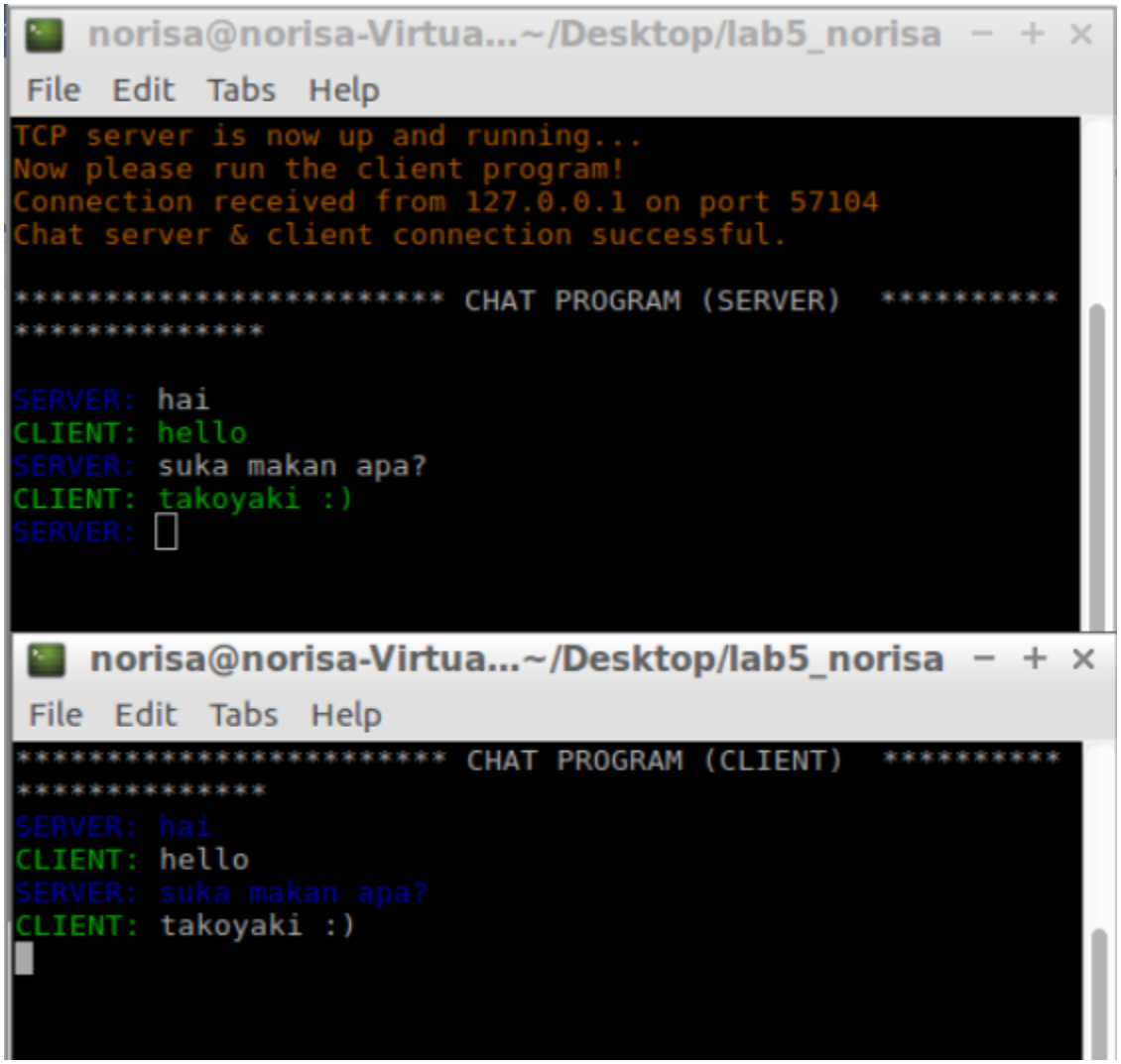
1. Write the code below into a new file named "**client.c**":

```
#include <sys/socket.h>
#include <sys/types.h>
#include <netinet/in.h>
#include <netdb.h>
#include <stdio.h>
#include <string.h>
#include <stdlib.h>
#include <unistd.h>
#include <errno.h>

#define    RED    "\x1B[31m"
#define   GREEN   "\x1B[32m"
#define  YELLOW   "\x1B[33m"
#define   BLUE    "\x1B[34m"
#define MAGENTA   "\x1B[35m"
#define   CYAN    "\x1B[36m"
#define   WHITE   "\x1B[37m"
#define RESET  "\033[0m"

int main()

{
    system("clear");

    int sock;
    int receivedBytes;
    char outgoing[1024];
    char incoming[1024];
    struct hostent  *host;
    struct sockaddr_in server_addr;

    host =  gethostbyname("127.0.0.1");

    if ((sock = socket(AF_INET, SOCK_STREAM, 0)) ==  -1)
    {
        perror("Socket");
        exit(1);
    }

    server_addr.sin_family = AF_INET;
    server_addr.sin_port = htons(5000);
    server_addr.sin_addr = *((struct in_addr *)host-
>h_addr);
    bzero(&(server_addr.sin_zero), 8);

    if (connect(sock, (struct sockaddr *)&server_addr,
sizeof(struct sockaddr)) == -1)
    {
        perror("Connect");
        exit(1);
```

```
    }

    printf("************************ CHAT PROGRAM
(CLIENT) ************************\n");

    while(1)
    {

        receivedBytes=recv(sock,incoming,1024,0);
        incoming[receivedBytes] =  '\0';
        printf(BLUE "SERVER: %s" RESET,  incoming);



        printf(GREEN "CLIENT: " RESET);
        fgets(outgoing, sizeof(outgoing), stdin);
        send(sock,outgoing,strlen(outgoing),  0);
    }

    return 0;
}
```

2. **Compile** the program.
3. Now that we have the server and the client, we can try to run these program to test it.
4. **Run** the **server** program.
5. Open **another Terminal** window, and **run** the **client** program here.
6. If everything is working, you can now exchange text between the server and client:




norisa@norisa-Virtua...~/Desktop/lab5_norisa
File Edit Tabs Help
TCP server is now up and running...
Now please run the client program!
Connection received from 127.0.0.1 on port 57104
Chat server & client connection successful.
********** CHAT PROGRAM (SERVER) **********
SERVER: hai
CLIENT: hello
SERVER: suka makan apa?
CLIENT: takoyaki :)
SERVER:
norisa@norisa-Virtua...~/Desktop/lab5_norisa
File Edit Tabs Help
********** CHAT PROGRAM (CLIENT) **********
SERVER: hai
CLIENT: hello
SERVER: suka makan apa?
CLIENT: takoyaki :)

PART 3: Complete the Tasks:

1. Modify the client-server program according to the new specifications below:
   a. **Client** will be asked for a valid **PIN number**. Whatever the user entered here will be **sent to server** for verification.

      (Note: User will need to run server before running client program)

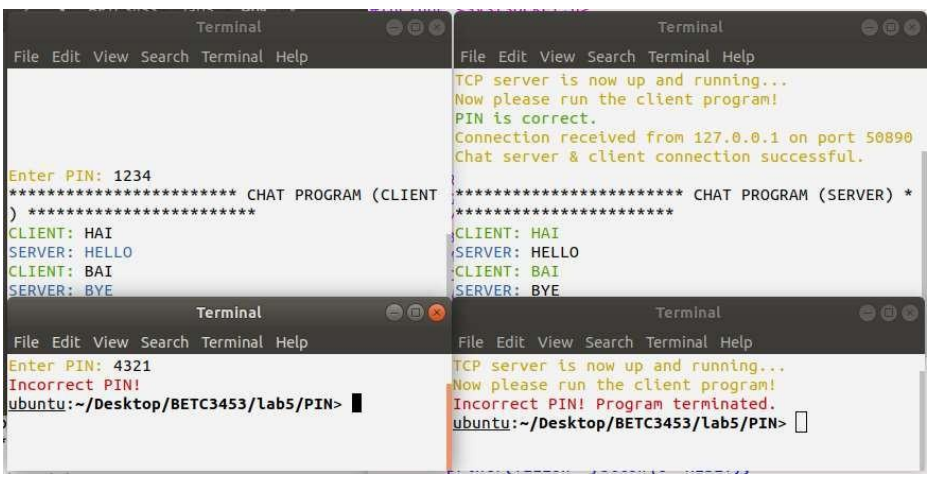
   b. **Server receives PIN** number from client and **checks** whether it is correct. There can be 2 possible outcomes of this process:

      i. If PIN number **is not "1234"**, server program will **terminate** with **message** "Incorrect PIN! Program terminated".

         At the same time, an **error message is sent to client**, and **client** will also **terminate** with message "Incorrect PIN!"

      ii. If PIN number **is "1234"**, server will **display message** "PIN is correct" and program will **proceed**.

   c. Chat program will run normally with client and server exchanging messages one message at a time. Note that **client** will **start sending the first message.**



Hint:

```
//Client

int main()

{

socket()
connect()

// send username to server for verification
    send()

// listen for message from server
    recv()

//check message from server
    if incoming="ERROR"
        exit(1);

//chat program starts
    while ()
}
```

```
//server

int main()

{

socket()
bind()
listen()
accept()

// listen for PIN
    recv()

// check PIN
    if incoming != "1234" {
        send() //set outgoing = "ERROR"
        exit(1);
    }

//chat program starts
    while ()

}
```

CODING:

Server:

st3.c

File Edit Search Options Help

```c
#include <sys/types.h>
#include <sys/socket.h>
#include <netinet/in.h>
#include <arpa/inet.h>
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <errno.h>
#include <string.h>

#define RED "\x1B[31m"
#define GREEN "\x1B[32m"
#define YELLOW "\x1B[33m"
#define BLUE "\x1B[34m"
#define MAGENTA "\x1B[35m"
#define CYAN "\x1B[36m"
#define WHITE "\x1B[37m"
#define RESET "\033[0m"

int main(){

system("clear");
/*
printf(RED "red\t" RESET);
printf(GREEN "green\t" RESET);
printf(YELLOW "yellow\t" RESET);
printf(BLUE "blue\t" RESET);
printf(MAGENTA "magenta\t" RESET);
printf(CYAN "cyan\t" RESET);
printf(WHITE "white\t" RESET);
printf("This is " RED "red" RESET " and this is " BLUE "blue" RESET "\n");
*/

int sock;
int connected;
int receivedBytes;
int true=1;
```

```
char outgoing[1024];
char incoming[1024];
char pin[1024];
char pinNo[1024];
struct sockaddr_in server_addr;
struct sockaddr_in client_addr;
int sin_size;

if((sock = socket(AF_INET, SOCK_STREAM, 0)) == -1){
perror("Socket Error");
exit(1);
}

if(setsockopt(sock, SOL_SOCKET, SO_REUSEADDR, &true,  sizeof(int)) == -1){
perror("Setsockopt Error");
exit(1);
}

server_addr.sin_family=AF_INET;
server_addr.sin_port=htons(5000);
server_addr.sin_addr.s_addr=INADDR_ANY;
bzero(&(server_addr.sin_zero),8);

if(bind(sock, (struct sockaddr *) &server_addr, sizeof (struct sockaddr)) ==-1){
perror("Bind Error");
exit(1);
}

if(listen(sock, 5) == -1){
perror("Listen Error");
exit(1);
}

printf(YELLOW "TCP server is now up and running...\n" RESET);
printf(YELLOW "Now please run the client program!\n" RESET);
fflush(stdout);

```

```
sin_size=sizeof(struct sockaddr_in);
connected=accept(sock, (struct sockaddr *) &client_addr, &sin_size);

//listen for pin
receivedBytes=recv(connected, pin, 1024, 0);
pin[receivedBytes]= '\0';
fflush(stdout);
//give value to pinNO
strcpy(pinNo, "1234\n");

//check pin
if(strcmp(pin,pinNo)!=0){
printf(RED "Incorrect PIN! Program terminated.\n" RESET);
send(connected,"Incorrect_PIN!\n", 20,0);
exit(1);
}
else{
printf(GREEN "Pin is correct.\n" RESET);
send(connected,"Correct_PIN!\n", 14,0);
}
printf(YELLOW "Connection received from %s on port %d \n" RESET, inet_ntoa(client_addr.sin_addr), ntohs(client_addr.sin_port));
printf(YELLOW "Chat server & client connection successful. \n\n" RESET);
printf( "************************ CHAT PROGRAM (SERVER)  ************************ \n\n");

while(1){
receivedBytes=recv(connected, incoming, 1024, 0);
incoming[receivedBytes]= '\0';
printf(GREEN "CLIENT: %s" RESET, incoming);
fflush(stdout);

printf(BLUE "SERVER: " RESET);
fgets(outgoing, sizeof(outgoing), stdin);
send(connected, outgoing, strlen(outgoing), 0);

}
close(sock);
return 0;
}
```

Client:

ct3.c

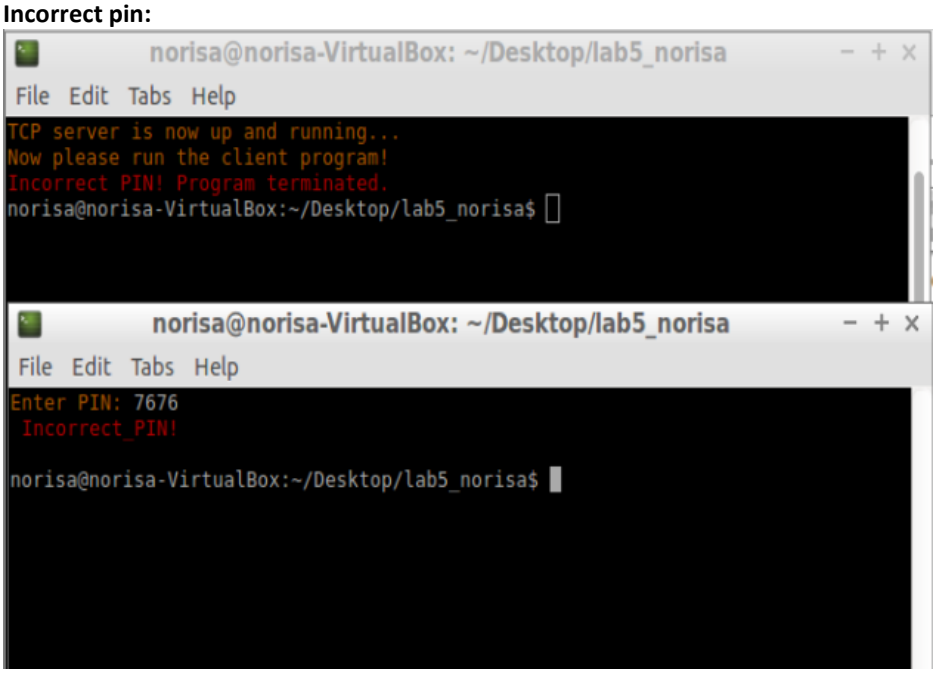
File Edit Search Options Help

```
#include <sys/types.h>
#include <sys/socket.h>
#include <netinet/in.h>
#include <netdb.h>
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <errno.h>
#include <string.h>

#define RED "\x1B[31m"
#define GREEN "\x1B[32m"
#define YELLOW "\x1B[33m"
#define BLUE "\x1B[34m"
#define MAGENTA "\x1B[35m"
#define CYAN "\x1B[36m"
#define WHITE "\x1B[37m"
#define RESET "\033[0m"

int main(){

system("clear");

int sock;
int receivedBytes;
char outgoing[1024];
char incoming[1024];
char pin[1024];
struct hostent *host;
struct sockaddr_in server_addr;
char checkP[1024];

host=gethostbyname("127.0.0.1");

if((sock = socket(AF_INET, SOCK_STREAM, 0)) == -1){
perror("Socket");
exit(1);
```

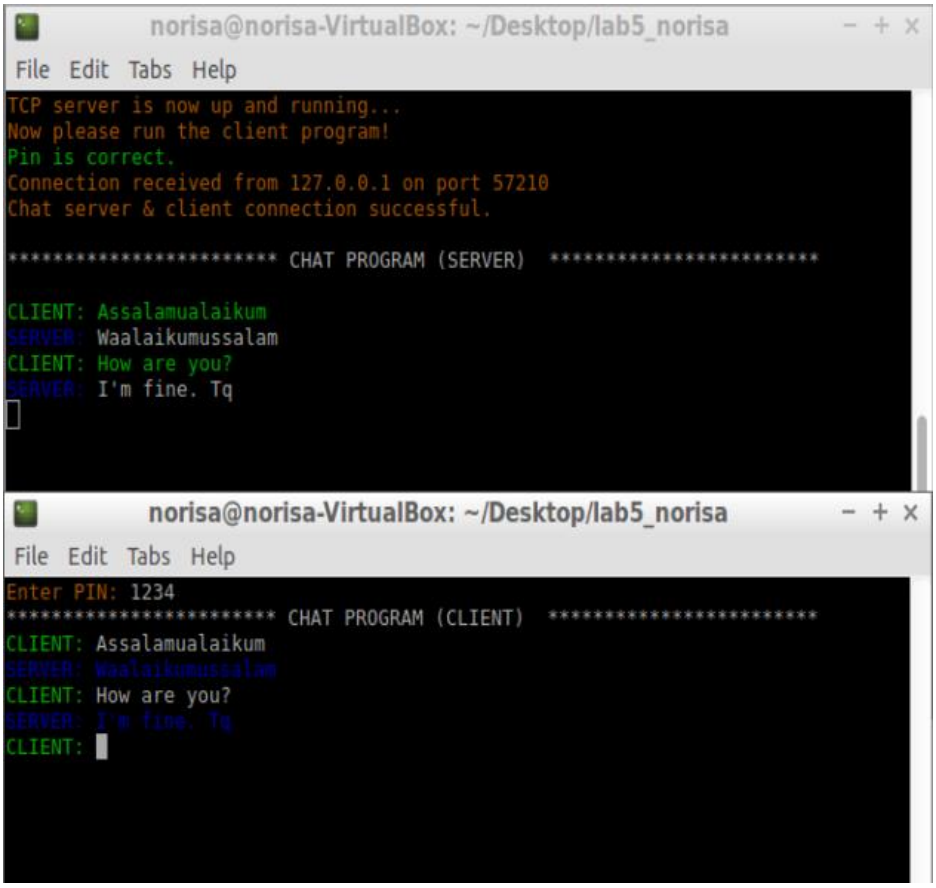
```
}

server_addr.sin_family=AF_INET;
server_addr.sin_port=htons(5000);
server_addr.sin_addr=*((struct in_addr *)host->h_addr);
bzero(&(server_addr.sin_zero),8);

if(connect(sock, (struct sockaddr *) &server_addr, sizeof (struct sockaddr)) ==-1){
perror("Connect");
exit(1);
}

//send verification
printf(YELLOW "Enter PIN: " RESET);
fgets(pin, sizeof(pin), stdin);
send(sock, pin, strlen(pin), 0);

//check message
strcpy(checkP, "Incorrect_PIN!\n");
receivedBytes=recv(sock, incoming, 1024, 0);
incoming[receivedBytes]= '\0';

if(strcmp(incoming, checkP)==0){
printf(RED " %s\n" RESET, incoming);
exit(1);
}

printf( "********************** CHAT PROGRAM (CLIENT)  ********************** \n");

while(1){
printf(GREEN "CLIENT: " RESET);
fgets(outgoing, sizeof(outgoing), stdin);
send(sock, outgoing, strlen(outgoing), 0);

receivedBytes=recv(sock, incoming, 1024, 0);
incoming[receivedBytes]= '\0';
printf(BLUE "SERVER: %s" RESET, incoming);

}
return 0;
}
```

OUTPUT:

Incorrect pin:



Correct Pin:



5. DISCUSSIONS & CONCLUSION

(What have you learned from this experiment?)

From this laboratory session, in part 1, we done coding to make the function of server where it will send message to the client first. So, we done the coding in part 2 for the client it will receive the message from the server and can reply to that message and both of them can keep receiving and sending message to each other. Then, for the task 3, we are required to do make a new coding for the server and client to send and receive each other, but need to input password first before doing that. So, the client will send the password first and then the server will check the password. The correct password is 1234, so if the client input password of 1234, the server will print Pin is Correct and they can start messaging where client will start to send message first to the server. But, if the client input different password other than 1234, they cannot start messaging and the message of "Incorrect PIN! Program terminated." Will be shown on server and message of "Incorrect PIN" will be shown on client side.

As a conclusion from this laboratory session, we are able to differentiate the functionality among various kinds of OS components. Then, we are also able to manipulate OS theories to solve basic functional problems and lastly, we are able to perform lab and present technical report in writing. Thus, objectives from this laboratory session are accomplished.