CODE:

1)Client.py :

```
# Python3 program imitating a client process

from timeit import default_timer as timer
from dateutil import parser
import threading
import datetime
import socket
import time


# client thread function used to send time at client side
def startSendingTime(slave_client):

    while True:
        # provide server with clock time at the client
        slave_client.send(str(datetime.datetime.now()).encode())

        print("Recent time sent successfully",end = "\n\n")
        time.sleep(5)


# client thread function used to receive synchronized time
def startReceivingTime(slave_client):

    while True:
        # receive data from the server
        Synchronized_time = parser.parse(slave_client.recv(1024).decode())

        print("Synchronized time at the client is: " + \str(Synchronized_time),end = "\n\n")


# function used to Synchronize client process time
def initiateSlaveClient(port = 8080):

    slave_client = socket.socket()

    # connect to the clock server on local computer
    slave_client.connect(('127.0.0.1', port))

    # start sending time to server
    print("Starting to receive time from server\n")
    send_time_thread = threading.Thread(target = startSendingTime,args = (slave_client, ))
    send_time_thread.start()


    # start receiving synchronized from server
    print("Starting to receiving " + \"synchronized time from server\n")
    receive_time_thread = threading.Thread(
                                        target = startReceivingTime,
                                        args = (slave_client, ))
    receive_time_thread.start()


# Driver function
if __name__ == '__main__':

    # initialize the Slave / Client
    initiateSlaveClient(port = 8080)
```

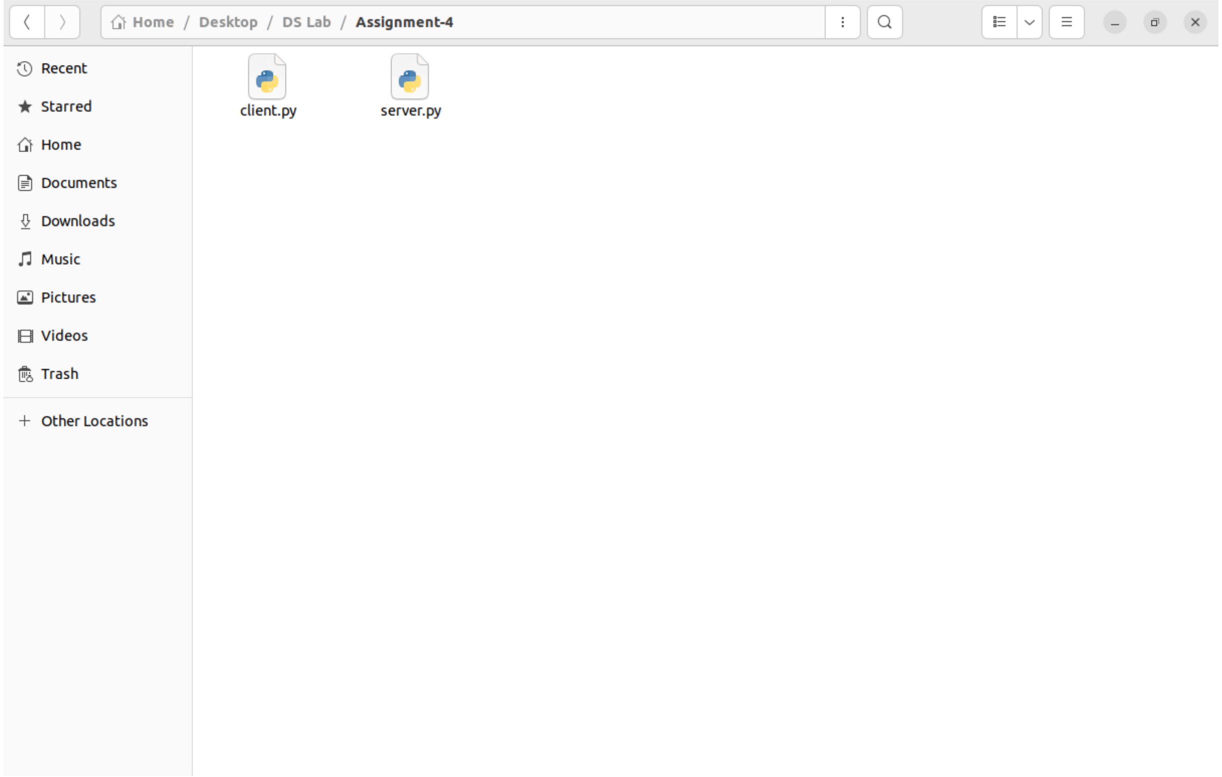
2)**Server.py :**

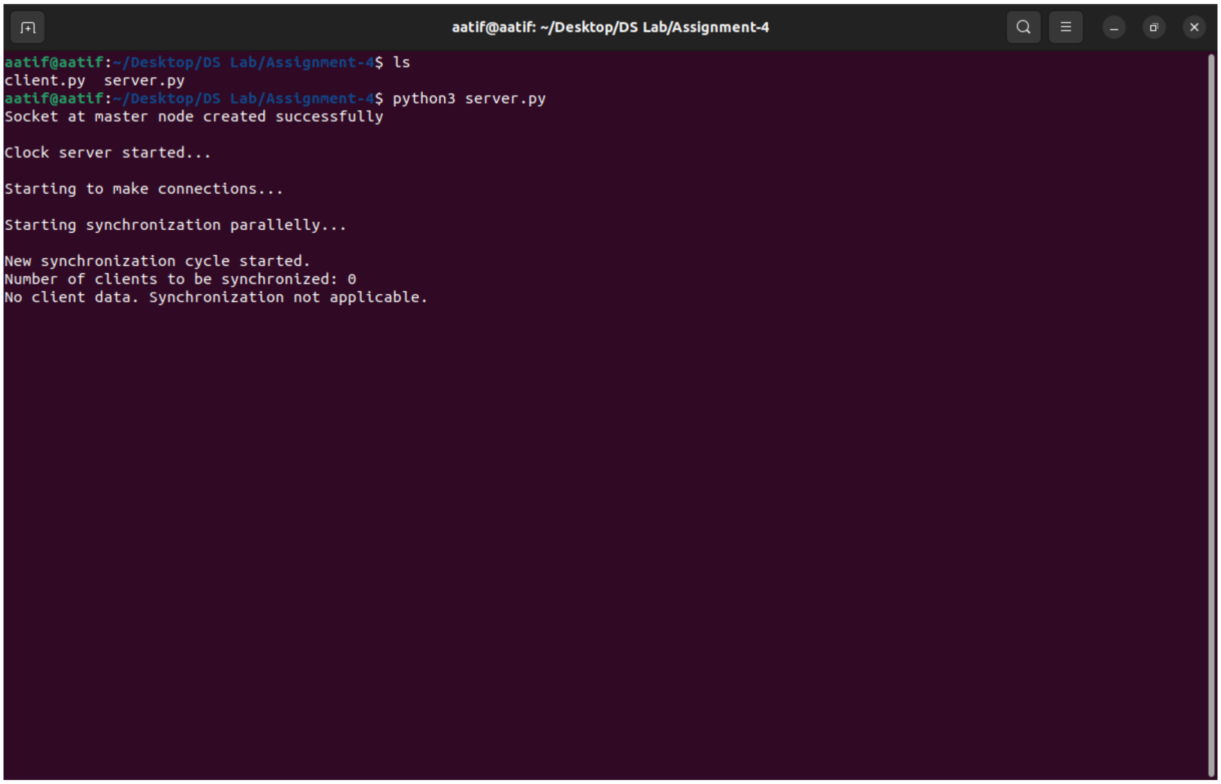
```
# Python3 program imitating a clock server
from dateutil import parser
import threading
import datetime
import socket
import time


# datastructure used to store client address and clock data
client_data = {}


''' nested thread function used to receive
    clock time from a connected client '''
def startReceivingClockTime(connector, address):

    while True:
        # receive clock time
        clock_time_string = connector.recv(1024).decode()
        clock_time = parser.parse(clock_time_string)
        clock_time_diff = datetime.datetime.now() - \
        clock_time

                client_data[address] = {
                                        "clock_time"    : clock_time,
                                        "time_difference" : clock_time_diff,
                                        "connector"     : connector
                                        }

                print("Client Data updated with: "+ str(address),
                                                                        end = "\n\n")
                time.sleep(5)


''' master thread function used to open portal for
        accepting clients over given port '''
def startConnecting(master_server):

        # fetch clock time at slaves / clients
        while True:
                # accepting a client / slave clock client
                master_slave_connector, addr = master_server.accept()
                slave_address = str(addr[0]) + ":" + str(addr[1])

                print(slave_address + " got connected successfully")

                current_thread = threading.Thread(
                                                target = startReceivingClockTime,
                                                args = (master_slave_connector,
                                                                        slave_address, ))
                current_thread.start()


# subroutine function used to fetch average clock difference
def getAverageClockDiff():
        time_difference_list = list(client['time_difference']
        for client_addr, client in client_data.items())


        sum_of_clock_difference = sum(time_difference_list, \ datetime.timedelta(0, 0))

        average_clock_difference = sum_of_clock_difference \ len(client_data)

        return average_clock_difference
```

```
''' master sync thread function used to generate cycles of clock synchronization in the network '''
def synchronizeAllClocks():

    while True:

        print("New synchronization cycle started.")
        print("Number of clients to be synchronized: " + \ str(len(client_data)))

        if len(client_data) > 0:

            average_clock_difference = getAverageClockDiff()

            for client_addr, client in client_data.items():
                try:
                    synchronized_time = \
                        datetime.datetime.now() + \
                                    average_clock_difference

                    client['connector'].send(str(synchronized_time).encode())

                except Exception as e:
                    print("Something went wrong while " + \
                        "sending synchronized time " + \
                        "through " + str(client_addr))

        else :
            print("No client data." + \" Synchronization not applicable.")

        print("\n\n")

        time.sleep(5)


# function used to initiate the Clock Server / Master Node
def initiateClockServer(port = 8080):

    master_server = socket.socket()
    master_server.setsockopt(socket.SOL_SOCKET,socket.SO_REUSEADDR, 1)

    print("Socket at master node created successfully\n")

    master_server.bind((", port))

    # Start listening to requests
    master_server.listen(10)
    print("Clock server started...\n")
```

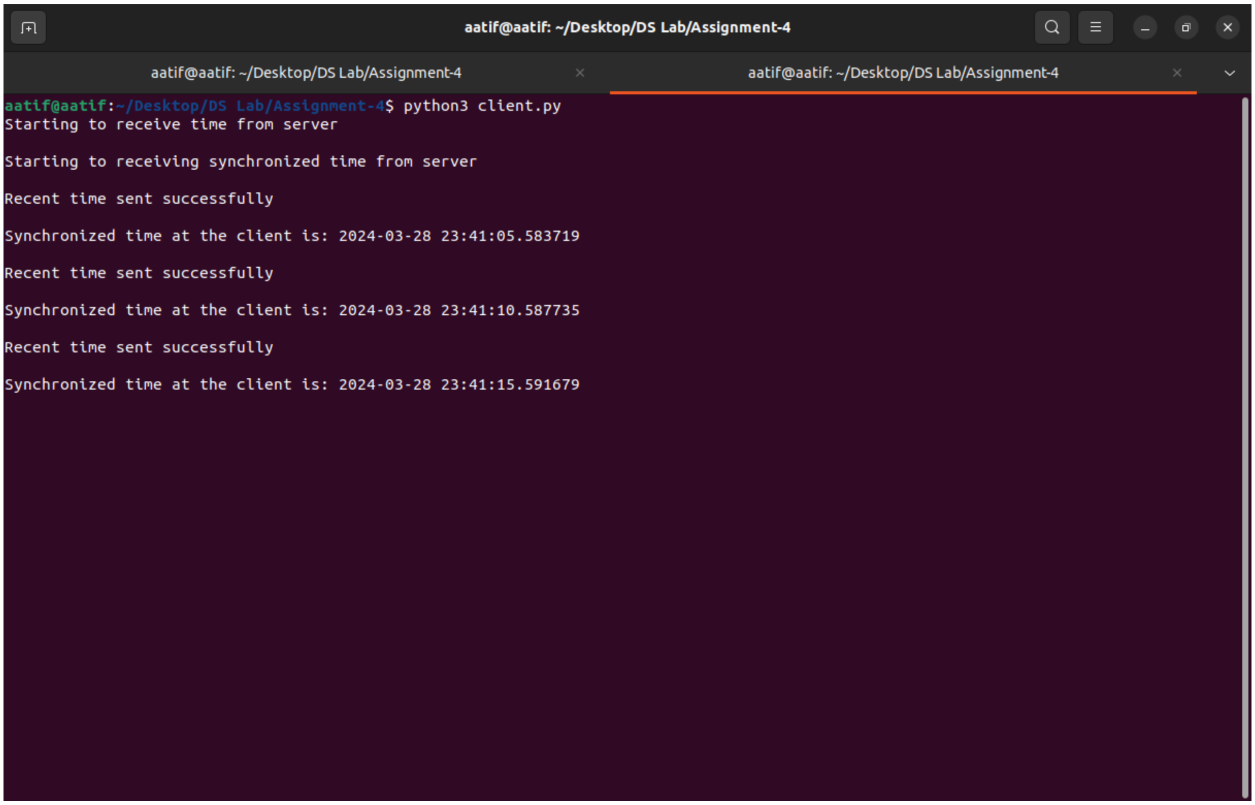
```
        # start making connections
        print("Starting to make connections...\n")
        master_thread = threading.Thread(target = startConnecting,args = (master_server, ))
        master_thread.start()

        # start synchronization
        print("Starting synchronization parallelly...\n")
        sync_thread = threading.Thread(target = synchronizeAllClocks,args = ())
        sync_thread.start()



# Driver function
if __name__ == '__main__':

        # Trigger the Clock Server
        initiateClockServer(port = 8080)
```

OUTPUT:



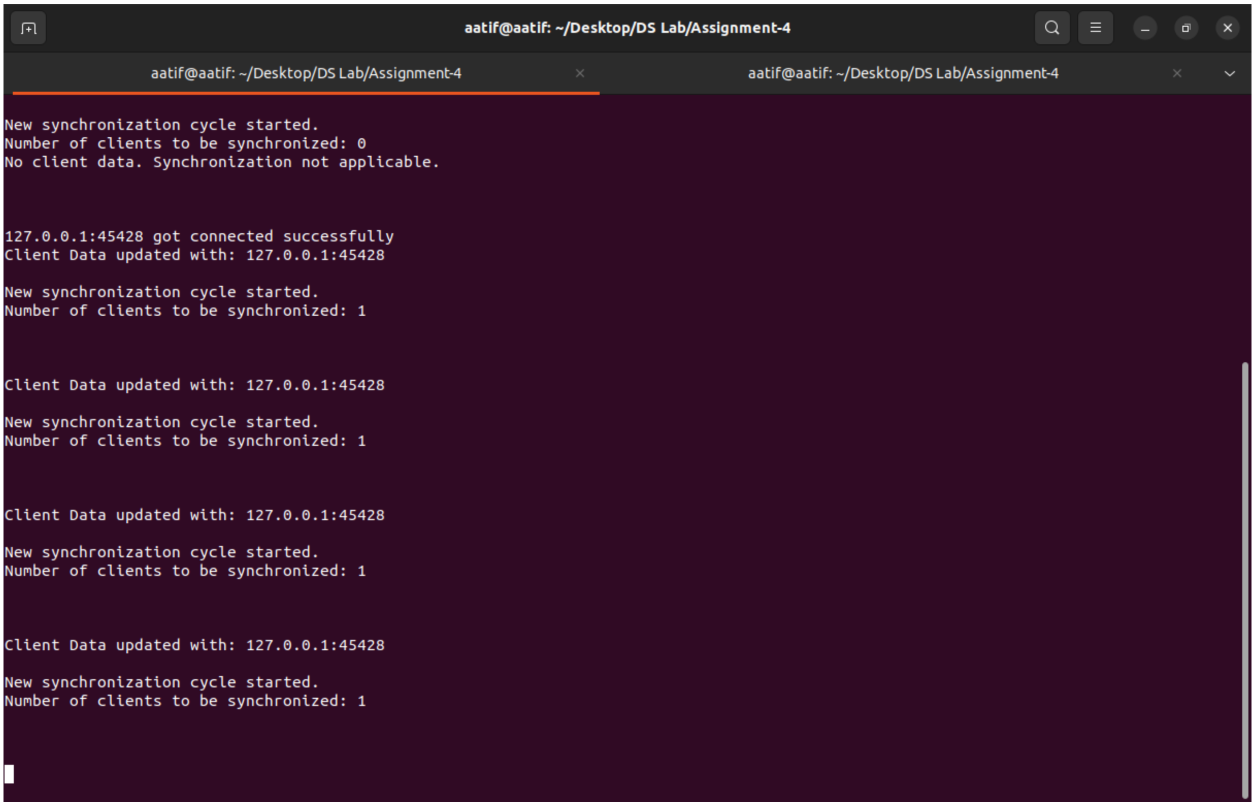


```
aatif@aatif:~/Desktop/DS Lab/Assignment-4$ ls
client.py  server.py
aatif@aatif:~/Desktop/DS Lab/Assignment-4$ python3 server.py
Socket at master node created successfully

Clock server started...

Starting to make connections...

Starting synchronization parallelly...

New synchronization cycle started.
Number of clients to be synchronized: 0
No client data. Synchronization not applicable.
```



aatif@aatif: ~/Desktop/DS Lab/Assignment-4
aatif@aatif: ~/Desktop/DS Lab/Assignment-4
aatif@aatif: ~/Desktop/DS Lab/Assignment-4

```
aatif@aatif:~/Desktop/DS Lab/Assignment-4$ python3 client.py
Starting to receive time from server

Starting to receiving synchronized time from server

Recent time sent successfully

Synchronized time at the client is: 2024-03-28 23:41:05.583719

Recent time sent successfully

Synchronized time at the client is: 2024-03-28 23:41:10.587735

Recent time sent successfully

Synchronized time at the client is: 2024-03-28 23:41:15.591679
```



aatif@aatif: ~/Desktop/DS Lab/Assignment-4
aatif@aatif: ~/Desktop/DS Lab/Assignment-4
aatif@aatif: ~/Desktop/DS Lab/Assignment-4

```
New synchronization cycle started.
Number of clients to be synchronized: 0
No client data. Synchronization not applicable.



127.0.0.1:45428 got connected successfully
Client Data updated with: 127.0.0.1:45428

New synchronization cycle started.
Number of clients to be synchronized: 1



Client Data updated with: 127.0.0.1:45428

New synchronization cycle started.
Number of clients to be synchronized: 1



Client Data updated with: 127.0.0.1:45428

New synchronization cycle started.
Number of clients to be synchronized: 1



Client Data updated with: 127.0.0.1:45428

New synchronization cycle started.
Number of clients to be synchronized: 1
```