COMPLEX ENGINEERING PROBLEM

THE BARBER SHOP PROBLEM

Report

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COURSE CODE: CS-329

COURSE TITLE: OPERATING SYSTEMS

SUBMITTED TO: Ms. UROOJ AINUDDIN

PROBLEM STATEMENT

Implement any one of the given classical synchronization problems using any appropriate system and application programming tools considering all the conditions and constraints specified in the problem statement.

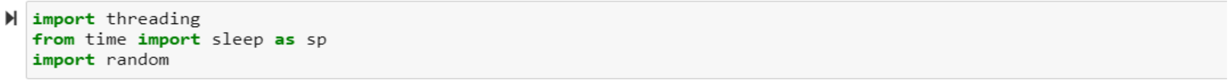
The Barbershop Problem:

A barbershop consists of a waiting room with n chairs, and the barber room containing the barber chair. If there are no customers to be served, the barber goes to sleep. If a customer enters the barbershop and all chairs are occupied, then the customer leaves the shop. If the barber is busy, but chairs are available, then the customer sits in one of the free chairs. If the barber is asleep, the customer wakes up the barber. Write a program to coordinate the barber and the customers. To make the problem a little more concrete, the following information is added:

- Customer threads should invoke a function named getHairCut.
- If a customer thread arrives when the shop is full, it can invoke balk, which does not return.
- Barber threads should invoke cutHair.
- When the barber invokes cutHair, there should be exactly one thread invoking getHairCut concurrently.

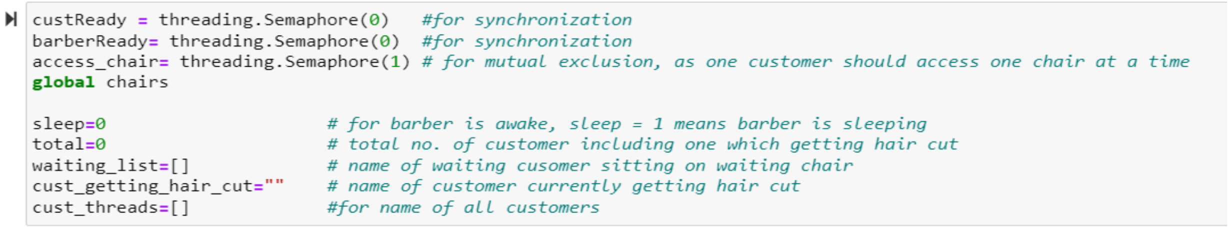
CODE

IMPORT PACKAGES



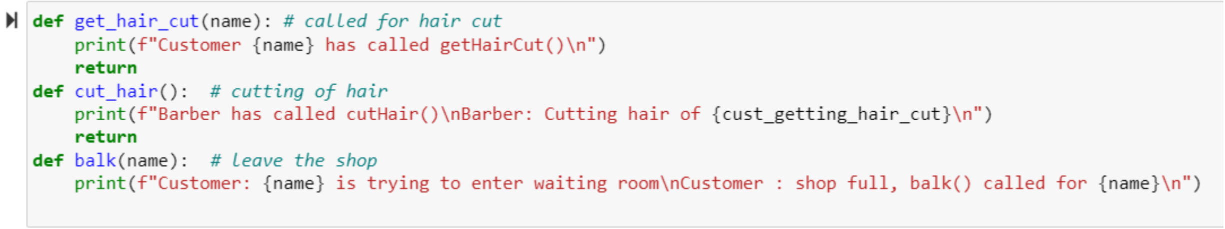
```
import threading
from time import sleep as sp
import random
```

INITIALIZATION



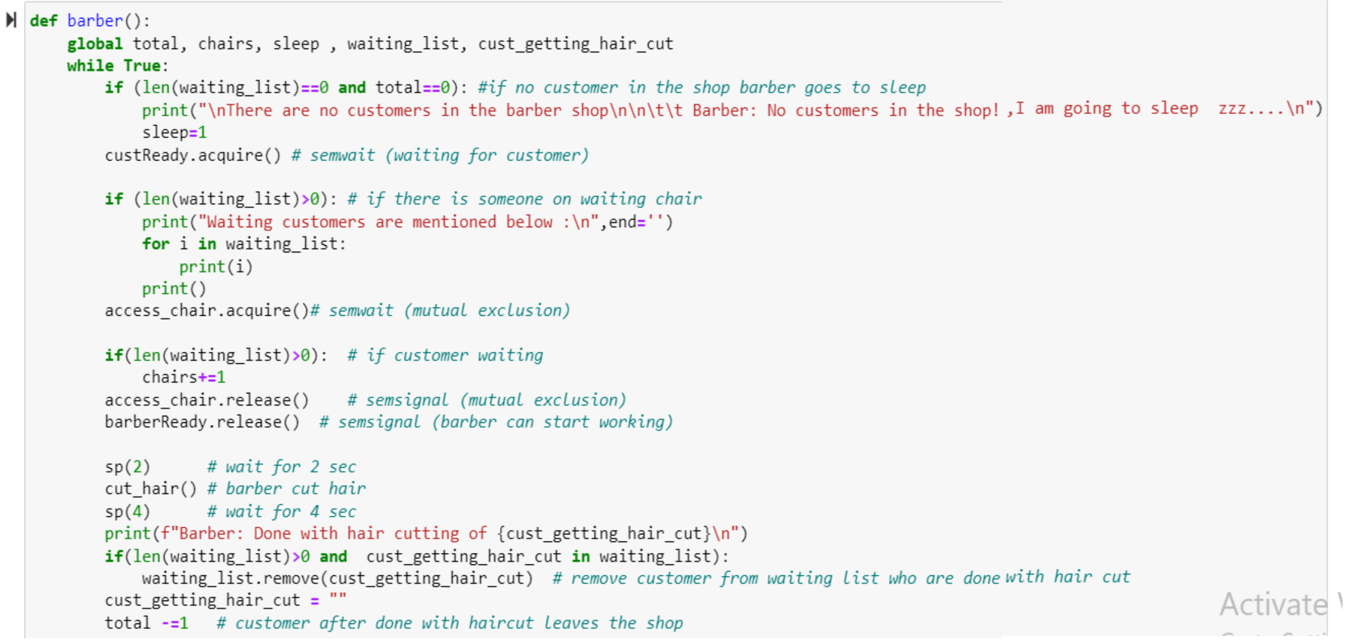
```
custReady = threading.Semaphore(0)   #for synchronization
barberReady= threading.Semaphore(0)  #for synchronization
access_chair= threading.Semaphore(1) # for mutual exclusion, as one customer should access one chair at a time
global chairs

sleep=0                      # for barber is awake, sleep = 1 means barber is sleeping
total=0                      # total no. of customer including one which getting hair cut
waiting_list=[]              # name of waiting cusomer sitting on waiting chair
cust_getting_hair_cut=""     # name of customer currently getting hair cut
cust_threads=[]              #for name of all customers
```

FUNCTIONS CALLED IN BARBER AND CUSTOMER ¶

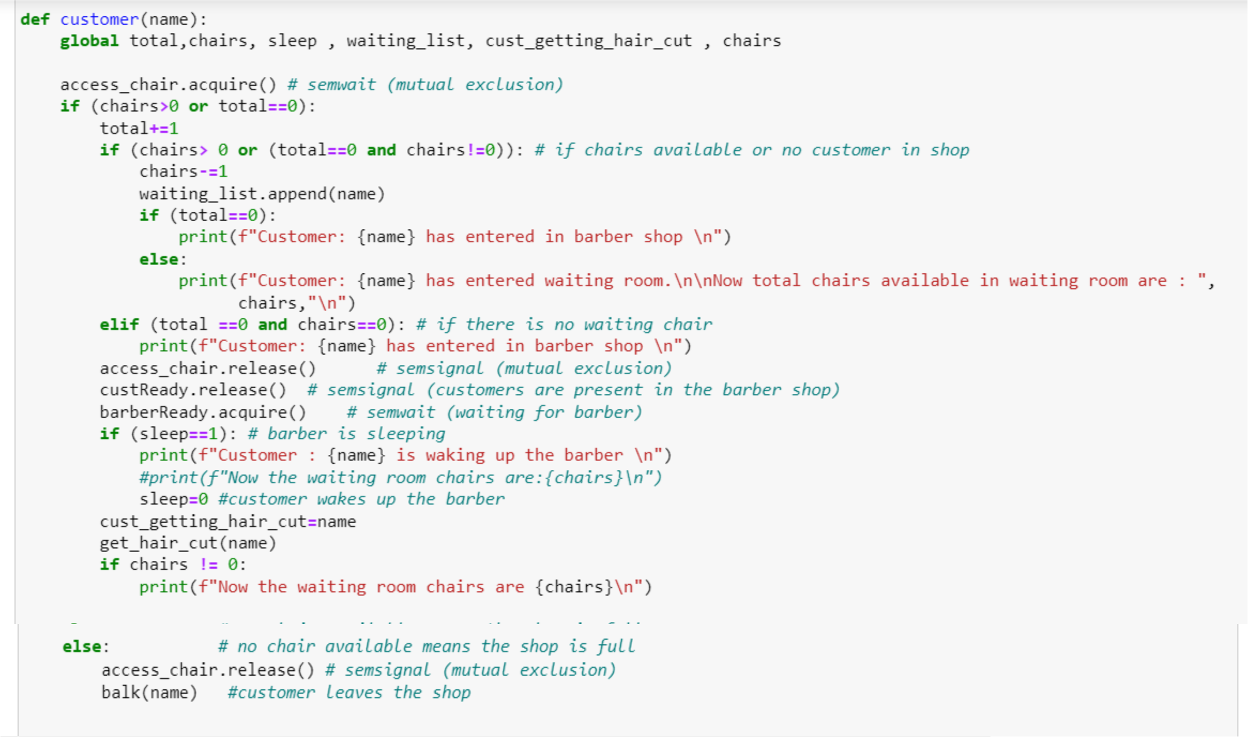


```
def get_hair_cut(name): # called for hair cut
    print(f"Customer {name} has called getHairCut()\n")
    return
def cut_hair():  # cutting of hair
    print(f"Barber has called cutHair()\nBarber: Cutting hair of {cust_getting_hair_cut}\n")
    return
def balk(name):  # leave the shop
    print(f"Customer: {name} is trying to enter waiting room\nCustomer : shop full, balk() called for {name}\n")
```

CUSTOMER AND BARBER

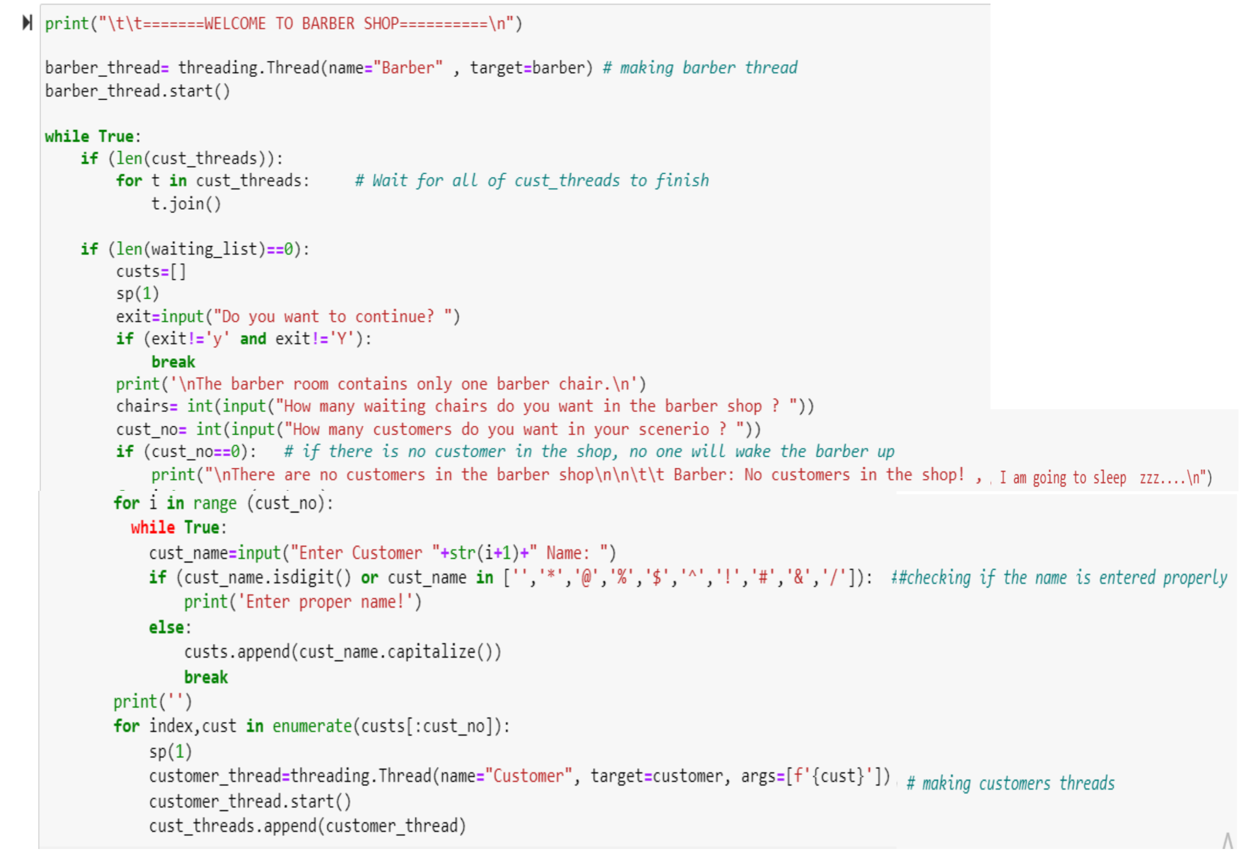


```
def barber():
    global total, chairs, sleep , waiting_list, cust_getting_hair_cut
    while True:
        if (len(waiting_list)==0 and total==0): #if no customer in the shop barber goes to sleep
            print("\nThere are no customers in the barber shop\n\n\t\t Barber: No customers in the shop! ,I am going to sleep  zzz....\n")
            sleep=1
        custReady.acquire() # semwait (waiting for customer)

        if (len(waiting_list)>0): # if there is someone on waiting chair
            print("Waiting customers are mentioned below :\n",end='')
            for i in waiting_list:
                print(i)
            print()
        access_chair.acquire()# semwait (mutual exclusion)

        if(len(waiting_list)>0):  # if customer waiting
            chairs+=1
        access_chair.release()    # semsignal (mutual exclusion)
        barberReady.release()  # semsignal (barber can start working)

        sp(2)      # wait for 2 sec
        cut_hair() # barber cut hair
        sp(4)      # wait for 4 sec
        print(f"Barber: Done with hair cutting of {cust_getting_hair_cut}\n")
        if(len(waiting_list)>0 and  cust_getting_hair_cut in waiting_list):
            waiting_list.remove(cust_getting_hair_cut)  # remove customer from waiting list who are done with hair cut
        cust_getting_hair_cut = ""
        total -=1   # customer after done with haircut leaves the shop
```



```python
def customer(name):
    global total,chairs, sleep , waiting_list, cust_getting_hair_cut , chairs

    access_chair.acquire() # semwait (mutual exclusion)
    if (chairs>0 or total==0):
        total+=1
        if (chairs> 0 or (total==0 and chairs!=0)): # if chairs available or no customer in shop
            chairs-=1
            waiting_list.append(name)
            if (total==0):
                print(f"Customer: {name} has entered in barber shop \n")
            else:
                print(f"Customer: {name} has entered waiting room.\n\nNow total chairs available in waiting room are : ",
                      chairs,"\n")
        elif (total ==0 and chairs==0): # if there is no waiting chair
            print(f"Customer: {name} has entered in barber shop \n")
        access_chair.release()      # semsignal (mutual exclusion)
        custReady.release()  # semsignal (customers are present in the barber shop)
        barberReady.acquire()    # semwait (waiting for barber)
        if (sleep==1): # barber is sleeping
            print(f"Customer : {name} is waking up the barber \n")
            #print(f"Now the waiting room chairs are:{chairs}\n")
            sleep=0 #customer wakes up the barber
        cust_getting_hair_cut=name
        get_hair_cut(name)
        if chairs != 0:
            print(f"Now the waiting room chairs are {chairs}\n")

    else:           # no chair available means the shop is full
        access_chair.release() # semsignal (mutual exclusion)
        balk(name)   #customer leaves the shop
```

MAIN INTERFACE



```python
print("\t\t=======WELCOME TO BARBER SHOP==========\n")

barber_thread= threading.Thread(name="Barber" , target=barber) # making barber thread
barber_thread.start()

while True:
    if (len(cust_threads)):
        for t in cust_threads:     # Wait for all of cust_threads to finish
            t.join()

    if (len(waiting_list)==0):
        custs=[]
        sp(1)
        exit=input("Do you want to continue? ")
        if (exit!='y' and exit!='Y'):
            break
        print('\nThe barber room contains only one barber chair.\n')
        chairs= int(input("How many waiting chairs do you want in the barber shop ? "))
        cust_no= int(input("How many customers do you want in your scenerio ? "))
        if (cust_no==0):   # if there is no customer in the shop, no one will wake the barber up
            print("\nThere are no customers in the barber shop\n\n\t\t Barber: No customers in the shop! , I am going to sleep  zzz....\n")
        for i in range (cust_no):
          while True:
            cust_name=input("Enter Customer "+str(i+1)+" Name: ")
            if (cust_name.isdigit() or cust_name in ['','*','@','%','$','^','!','#','&','/']):  ##checking if the name is entered properly
                print('Enter proper name!')
            else:
                custs.append(cust_name.capitalize())
                break
        print('')
        for index,cust in enumerate(custs[:cust_no]):
            sp(1)
            customer_thread=threading.Thread(name="Customer", target=customer, args=[f'{cust}'])  # making customers threads
            customer_thread.start()
            cust_threads.append(customer_thread)
```

TEST CASES:

CASE 1 (NORMAL EXECUTION CASE)

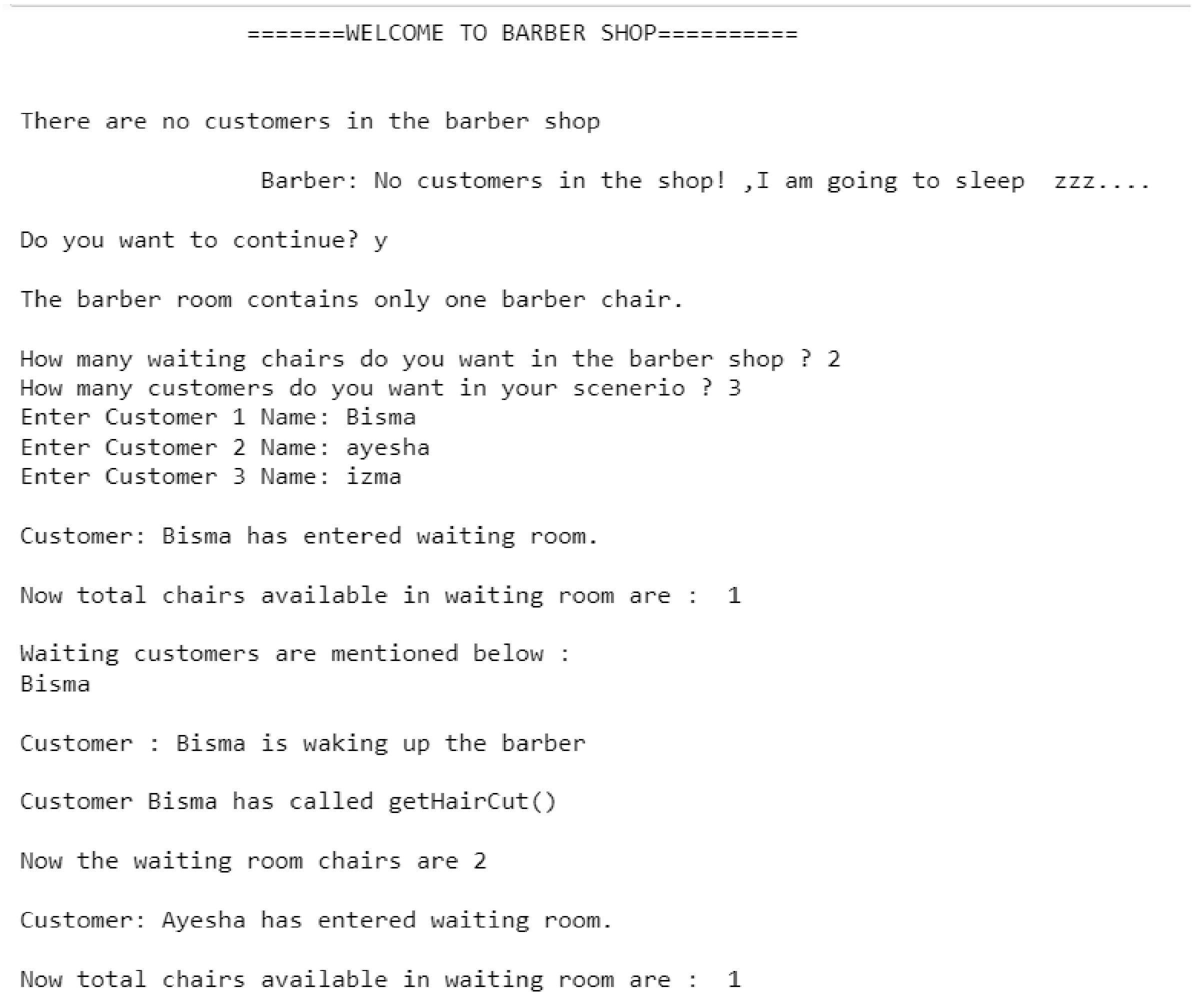
Number of chairs in waiting room: 2

Total number of customers: 3

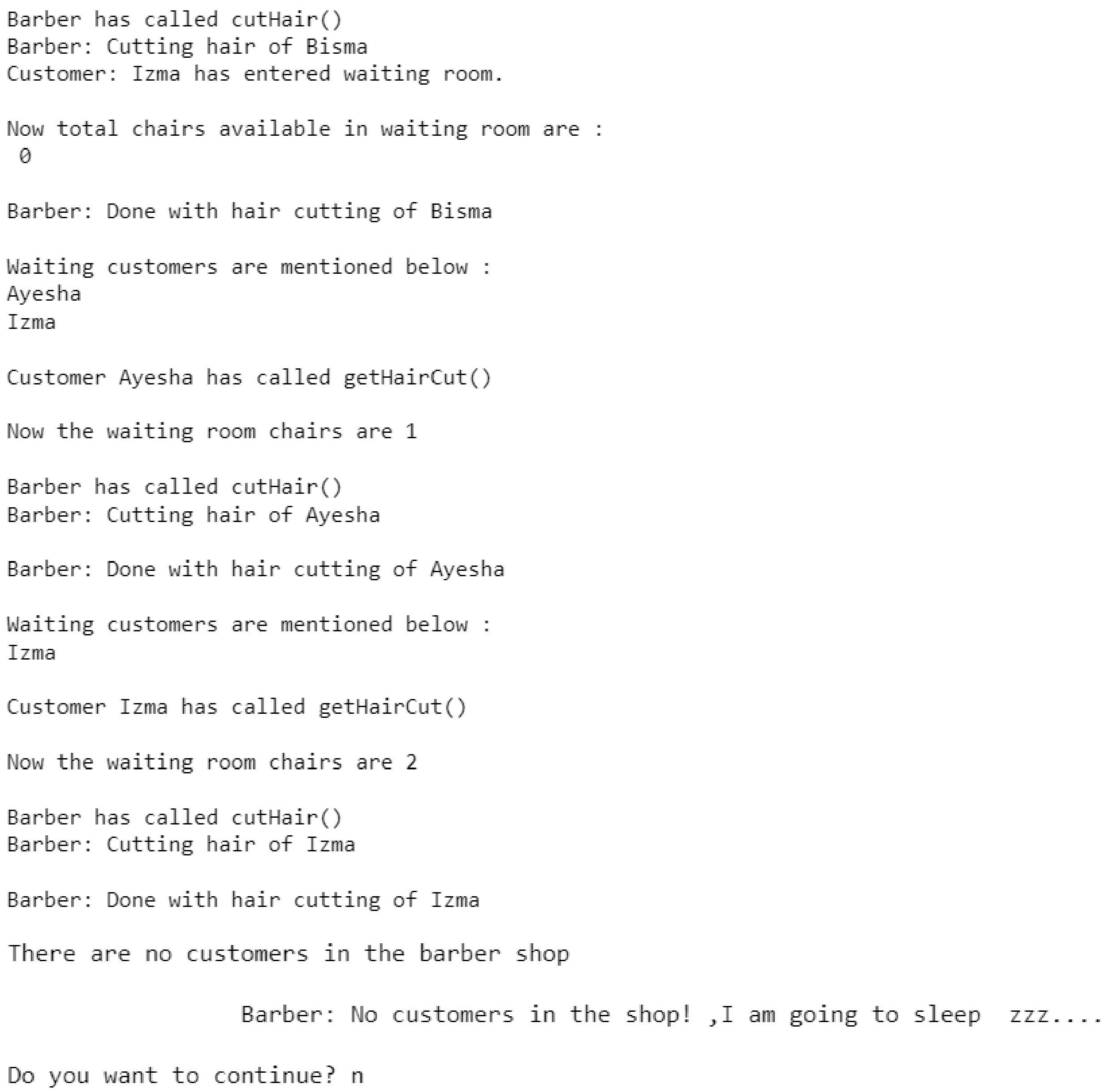
EXPECTED OUTPUT:

All of the three customers will get hair cut one after another without any problem.

ACTUAL OUTPUT:



```
                 =======WELCOME TO BARBER SHOP==========


 There are no customers in the barber shop

                  Barber: No customers in the shop! ,I am going to sleep  zzz....

 Do you want to continue? y

 The barber room contains only one barber chair.

 How many waiting chairs do you want in the barber shop ? 2
 How many customers do you want in your scenerio ? 3
 Enter Customer 1 Name: Bisma
 Enter Customer 2 Name: ayesha
 Enter Customer 3 Name: izma

 Customer: Bisma has entered waiting room.

 Now total chairs available in waiting room are :  1

 Waiting customers are mentioned below :
 Bisma

 Customer : Bisma is waking up the barber

 Customer Bisma has called getHairCut()

 Now the waiting room chairs are 2

 Customer: Ayesha has entered waiting room.

 Now total chairs available in waiting room are :  1
```



```
Barber has called cutHair()
Barber: Cutting hair of Bisma
Customer: Izma has entered waiting room.

Now total chairs available in waiting room are :
 0

Barber: Done with hair cutting of Bisma

Waiting customers are mentioned below :
Ayesha
Izma

Customer Ayesha has called getHairCut()

Now the waiting room chairs are 1

Barber has called cutHair()
Barber: Cutting hair of Ayesha

Barber: Done with hair cutting of Ayesha

Waiting customers are mentioned below :
Izma

Customer Izma has called getHairCut()

Now the waiting room chairs are 2

Barber has called cutHair()
Barber: Cutting hair of Izma

Barber: Done with hair cutting of Izma

There are no customers in the barber shop

                  Barber: No customers in the shop! ,I am going to sleep  zzz....

Do you want to continue? n
```

CASE 2 (BALK CASE)

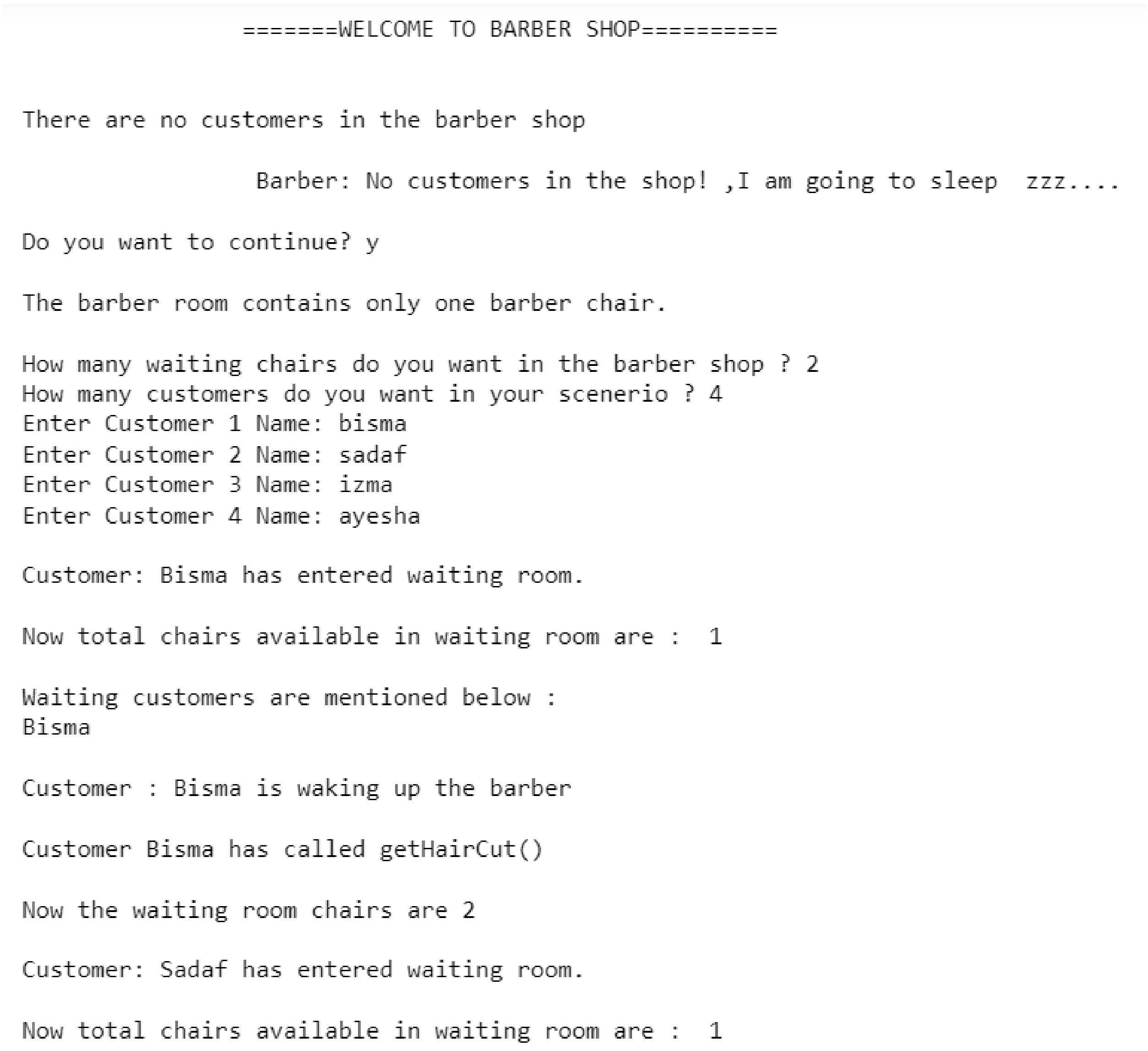
Number of chairs in waiting room: 2

Total number of customers: 4

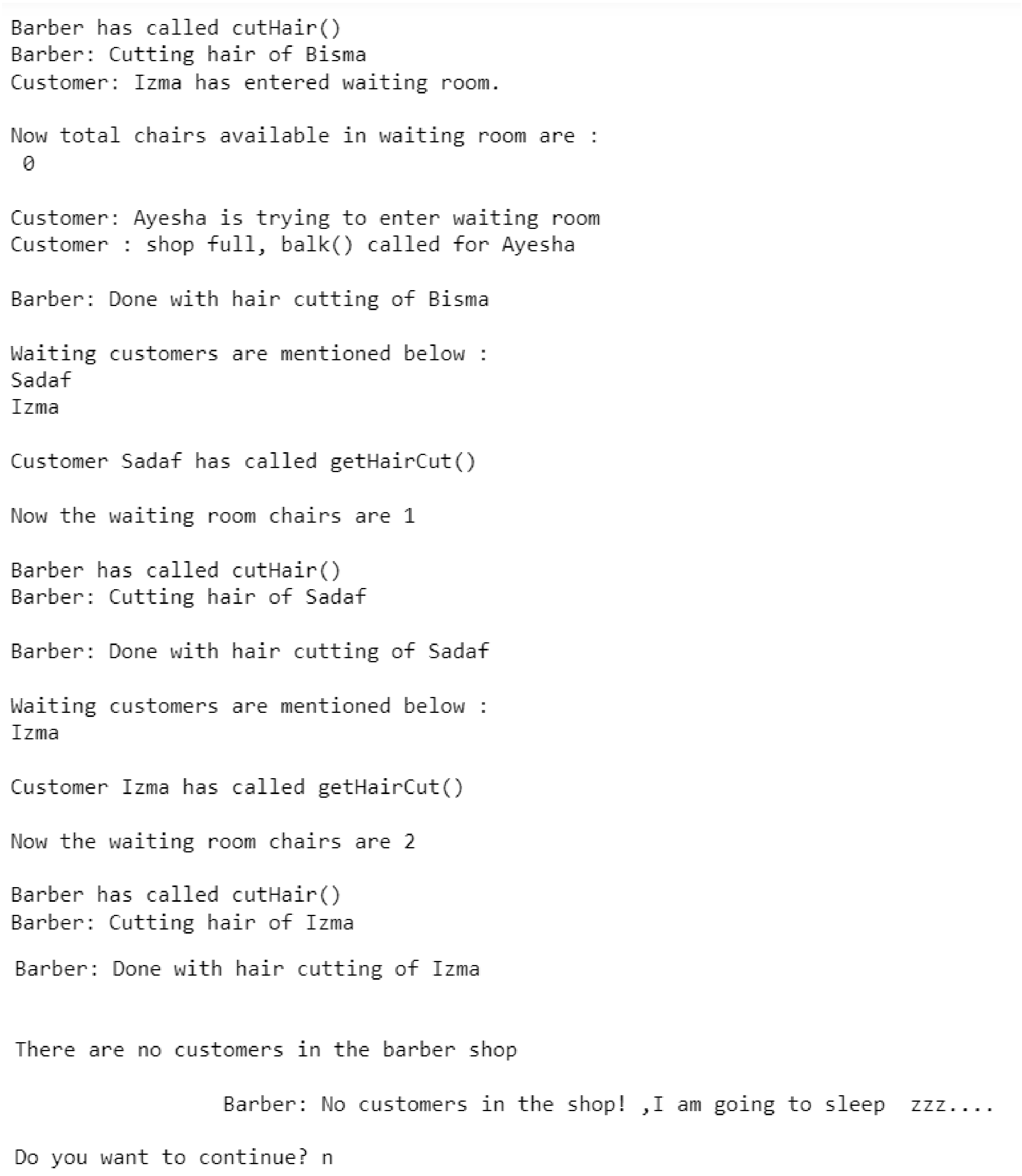
EXPECTED OUTPUT:

Balk function is called for 4th customer as there are no chairs left in the waiting room (Total chairs available in the waiting room are: 0).

ACTUAL OUTPUT:



```
                  =======WELCOME TO BARBER SHOP==========


 There are no customers in the barber shop

                  Barber: No customers in the shop! ,I am going to sleep  zzz....

 Do you want to continue? y

 The barber room contains only one barber chair.

 How many waiting chairs do you want in the barber shop ? 2
 How many customers do you want in your scenerio ? 4
 Enter Customer 1 Name: bisma
 Enter Customer 2 Name: sadaf
 Enter Customer 3 Name: izma
 Enter Customer 4 Name: ayesha

 Customer: Bisma has entered waiting room.

 Now total chairs available in waiting room are :  1

 Waiting customers are mentioned below :
 Bisma

 Customer : Bisma is waking up the barber

 Customer Bisma has called getHairCut()

 Now the waiting room chairs are 2

 Customer: Sadaf has entered waiting room.

 Now total chairs available in waiting room are :  1
```



```
Barber has called cutHair()
Barber: Cutting hair of Bisma
Customer: Izma has entered waiting room.

Now total chairs available in waiting room are :
 0

Customer: Ayesha is trying to enter waiting room
Customer : shop full, balk() called for Ayesha

Barber: Done with hair cutting of Bisma

Waiting customers are mentioned below :
Sadaf
Izma

Customer Sadaf has called getHairCut()

Now the waiting room chairs are 1

Barber has called cutHair()
Barber: Cutting hair of Sadaf

Barber: Done with hair cutting of Sadaf

Waiting customers are mentioned below :
Izma

Customer Izma has called getHairCut()

Now the waiting room chairs are 2

Barber has called cutHair()
Barber: Cutting hair of Izma
Barber: Done with hair cutting of Izma


There are no customers in the barber shop

                 Barber: No customers in the shop! ,I am going to sleep  zzz....

Do you want to continue? n
```

CASE 3 (NO WAITING CHAIRS)

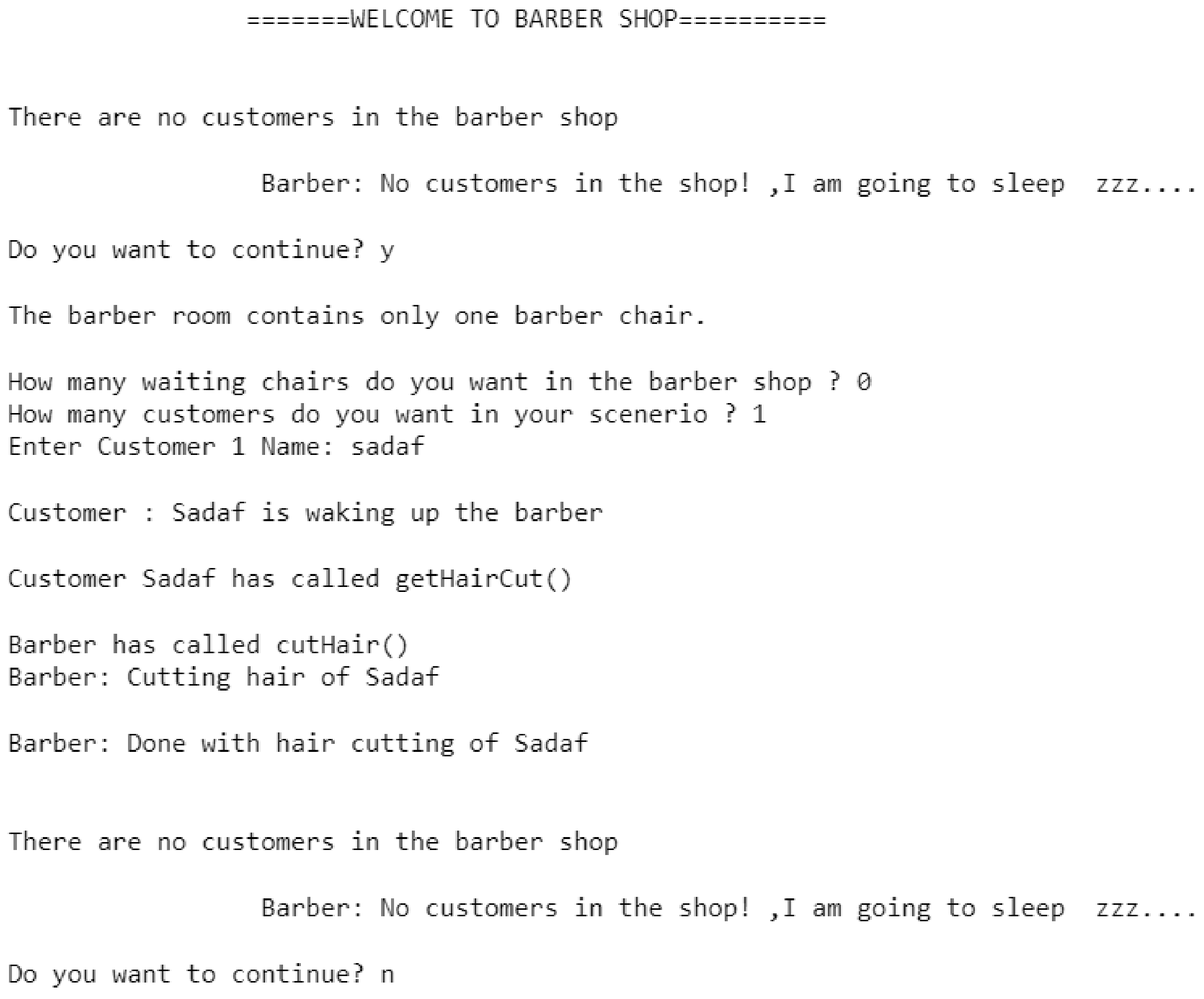
Number of chairs in waiting room: 0

Total number of customers: 1

EXPECTED OUTPUT:

As there is no waiting chair and only 1 customer enters the shop so he will directly wake up the barber and sit on the barber chair without any wait.

ACTUAL OUTPUT:



```
                    =======WELCOME TO BARBER SHOP==========


 There are no customers in the barber shop

                   Barber: No customers in the shop! ,I am going to sleep  zzz....

 Do you want to continue? y

 The barber room contains only one barber chair.

 How many waiting chairs do you want in the barber shop ? 0
 How many customers do you want in your scenerio ? 1
 Enter Customer 1 Name: sadaf

 Customer : Sadaf is waking up the barber

 Customer Sadaf has called getHairCut()

 Barber has called cutHair()
 Barber: Cutting hair of Sadaf

 Barber: Done with hair cutting of Sadaf


 There are no customers in the barber shop

                   Barber: No customers in the shop! ,I am going to sleep  zzz....

 Do you want to continue? n
```

CASE 4 (ZERO CUSTOMERS)

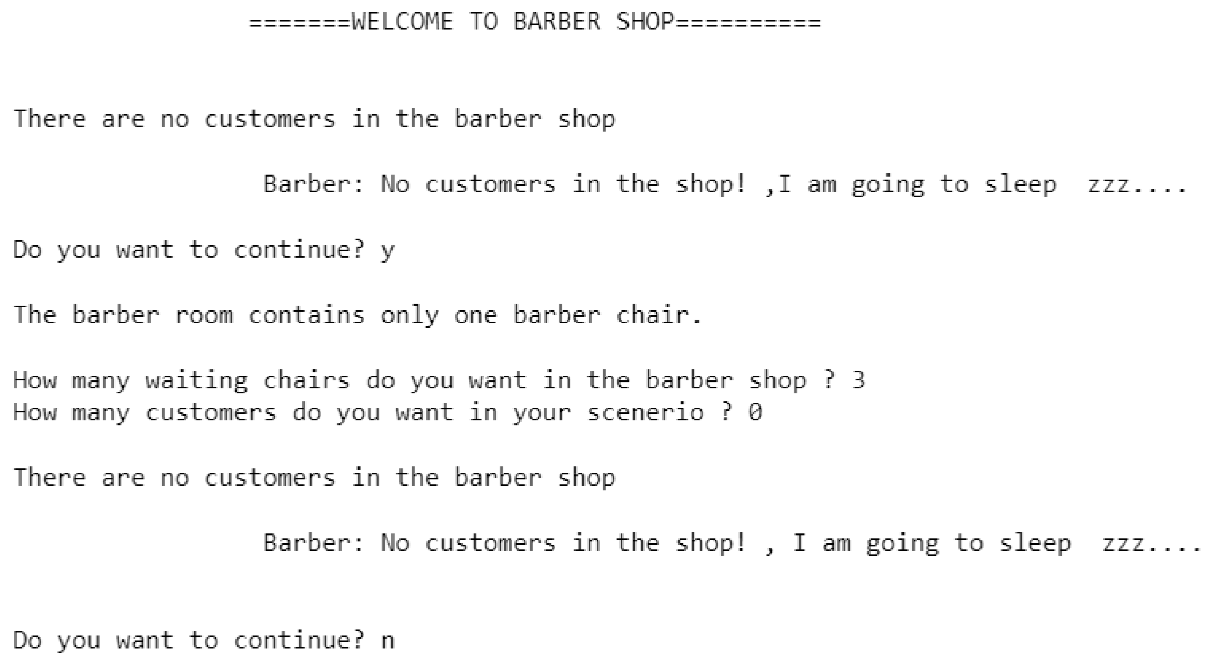
Number of chairs in waiting room: 3

Total number of customers: 0

EXPECTED OUTPUT:

As there is no customer so barber will remain asleep.

ACTUAL OUTPUT:



```
                 =======WELCOME TO BARBER SHOP==========


 There are no customers in the barber shop

                  Barber: No customers in the shop! ,I am going to sleep  zzz....

 Do you want to continue? y

 The barber room contains only one barber chair.

 How many waiting chairs do you want in the barber shop ? 3
 How many customers do you want in your scenerio ? 0

 There are no customers in the barber shop

                  Barber: No customers in the shop! , I am going to sleep  zzz....


 Do you want to continue? n
```